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United States
Department of
Agriculture

Research and
Education Committee

September 1987

1986 Annual Report on the Food and Agricultural Sciences

From the Secretary of Agriculture
to the President and the Congress
of the United States

PREFACE

This report was prepared under the auspices of the USDA Research and Education Committee, which was established in 1981 as a unit of the Secretary of Agriculture's Policy and Coordination Council. The Assistant Secretary of Agriculture for Science and Education serves as chairperson of the Committee.

USDA agency representatives who assisted in preparing this report were Jack H. Armstrong, Agricultural Cooperative Service; Charles R. Brader, Agricultural Marketing Service; James T. Hall, Agricultural Research Service; Charles G. Kreysa, Animal and Plant Health Inspection Service; Edward M. Wilson, Cooperative State Research Service; Bruce L. Greenshields, Economic Research Service; Judith A. Bowers, Extension Service; Leslie E. Malone, Federal Grain Inspection Service; George H. Moeller, Forest Service; Betty B. Peterkin, Human Nutrition Information Service; Eugene M. Farkas, National Agricultural Library; Frederic A. Vogel, National Agricultural Statistics Service; Robert W. Werge, Office of International Cooperation and Development; and Wesley R. Kriebel, Office of Transportation.

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CONTENTS

FEDERAL, STATE, AND PRIVATE INDUSTRY SUPPORT FOR THE FOOD AND AGRICULTURAL SCIENCES 1

Department of Agriculture 1
State and County Support 8
Private Industry Research and Development 9

SELECTED SIGNIFICANT ACTIVITIES AND ACCOMPLISHMENTS IN THE FOOD AND AGRICULTURAL SCIENCES 10

Agricultural Research Service 10
Cooperative State Research Service 18
National Agricultural Statistics Service 21
Economic Research Service 25
Agricultural Cooperative Service 28
Animal and Plant Health Inspection Service 30
Human Nutrition Information Service 33
Agricultural Marketing Service 35
Office of Transportation 38
Office of International Cooperation
and Development 40
Forest Service 44
Federal Grain Inspection Service 53
Extension Service 55
National Agricultural Library 60

FOOD AND AGRICULTURAL SCIENCE PRIORITIES AND DIRECTIONS FOR THE FUTURE 63

Departmental Objectives 63
National Priorities Recommended by the
Joint Council on Food and Agricultural
Sciences 64

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FEDERAL, STATE, AND PRIVATE INDUSTRY SUPPORT FOR THE FOOD AND AGRICULTURAL SCIENCES

DEPARTMENT OF AGRICULTURE

The U.S. Department of Agriculture's research and education (R&E) agencies supported food and agriculture research, extension, and teaching programs funded at approximately \$1,290 million in FY 1986, down 3.3 percent from FY 1985. These programs were centered in the Agricultural Research Service, Cooperative State Research Service, Extension Service, National Agricultural Library, Forest Service, and Economic Research Service. Other agencies having research and education activities include the Agricultural Cooperative Service, Animal and Plant Health Inspection Service, Agricultural Marketing Service, Human Nutrition Information Service, Office of International Cooperation and Development, Office of Transportation, National Agricultural Statistics Service, and Federal Grain Inspection Service. USDA research and education program funding for fiscal year 1987 is estimated to be \$1,357 million (table 1).

The research and education programs of the Department are complementary and mutually supportive in providing new knowledge, technology, and information on food, agriculture, and forestry issues vital to producers, marketing firms, consumers, and action agencies. The results of these efforts affect the total economy of the United States and millions of consumers here and abroad. Including input supply production, processing, and marketing, the agriculture and forestry sectors account for more than 20 percent of the gross national product and employment in the United States. These sectors also provided \$5.45 billion in export trade surpluses in FY 1986. This helped to slightly offset huge and increasing trade deficits in other categories. At home, the cost of food to consumers as a share of disposable income continues to decline.

In 1986, food required only 14.7 percent of U.S. consumers' disposable income, down from 16.3 percent in 1976. At the farm level, food costs for U.S. consumers in 1986, as a percentage of disposable income, were less than 4 percent, since 75 percent of the cost of food is due to food marketing costs. In 1986, food processing cost \$80 billion, wholesaling, retailing, and transportation another \$135 billion, and food and beverage services (restaurants, fast food establishments, etc.) over \$60 billion. Labor costs alone for marketing were 44 percent higher in 1986 than the cost of food at the farm level.

USDA research and education programs address national issues in production efficiency, export markets, marketing efficiency, natural resources management and conservation, human and community development, and human nutrition. Research programs financed by the Department, encompassing this complex array of issues, represented about 2.0 percent of the \$52.0 billion obligated for Federal research in FY 1986.

The Secretary of Agriculture has identified research and extension as one of the Department's five major goals. The research and education programs provide major underpinnings for the remaining goals, which are (1) a strong, healthy agricultural economy, (2) food and fiber for peace and economic stability, (3) resource conservation, and (4) support for State and local governments.

Funding for USDA research and education programs has increased in current dollars from \$933 million in FY 1979 to \$1,357 million for FY 1987 (table 1 and fig. 1). However, the gain in current dollars for research and education was more than offset by inflation over the period. In constant 1979 dollars, funding actually declined from \$933 million in FY 1979 to \$873 million in FY 1987 (table 2 and fig. 2).

The overall R&E funding in constant dollars over the FY 1979-87 period has trended downward and in FY 1987 was 6.5 percent below FY 1979. USDA funding for research in constant dollars was highest in 1985, and next highest in 1979. Funding for education in constant dollars declined in all years except 1983 from 1979 to date (table 2 and fig. 2).

Differences in funding were apparent among the R&E agencies. Four agencies operating R&E programs over the FY 1979-87 period had funding increases more than sufficient to cover inflation; two maintained a level sufficient to match inflation; and seven did not receive increases large enough to cover inflation (table 3).¹

¹CSRS received funding increases for research programs; however, the Agency did not receive large enough increases to cover inflation for its educational programs.

Table 1.
U.S. Department of Agriculture: Appropriations for research and education, FY 1979-87

Item	1979	1980	1981	1982	1983	1984	1985	1986 ^{1/}	1987
	Million dollars								
<u>Research</u>									
Agricultural Research Service ^{2/}	328.0	358.0	404.1	423.2	451.9	469.0	492.1	483.2	517.2
Cooperative State Research Service ^{3/}									
Hatch Act Formula	109.1	118.6	128.6	141.1	147.2	152.3	156.5	148.8	148.8
Cooperative Forestry	9.5	10.0	10.8	12.0	12.4	12.7	13.1	12.4	12.4
1890 Colleges and Tuskegee	16.4	17.8	19.3	21.5	21.8	22.8	23.5	22.3	22.3
Special Research Grants	16.3	15.2	18.2	23.1	27.8	26.5	33.2	29.0	52.0
Competitive Research Grants	15.0	15.5	16.0	16.3	17.0	17.0	46.0	42.3	40.7
Rural Development Research	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Animal Health and Disease	5.0	6.0	6.5	5.8	5.8	5.8	5.8	5.5	5.5
Direct Federal Administration	1.5	1.3	1.3	0.8	0.3	0.6	1.5	1.5	2.6
Forestry Competitive Grants	0.0	0.0	0.0	0.0	0.0	0.0	7.8	6.5	4.5
Total, CSRS ^{3/}	174.3	185.9	200.7	220.6	232.3	237.7	287.4	268.3	288.8
National Agricultural Statistics Serv.	5.4	5.0	7.5	7.0	7.6	8.2	8.4	8.0	8.2
Economic Research Service	28.2	26.1	39.5	39.4	38.8	44.3	47.1	44.1	45.4
Human Nutrition Information Service	6.6	7.1	8.2	8.5	7.7	6.1	7.5	12.9	6.9
Animal and Plant Health Inspection Serv.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	4.7
Agricultural Cooperative Service	2.0	1.6	1.8	1.7	2.2	2.2	2.9	2.7	2.7
Agricultural Marketing Service	1.0	1.3	1.4	1.5	1.5	1.6	1.6	1.5	1.5
Office of Transportation	0.7	0.8	0.9	1.0	0.8	0.8	1.3	1.1	1.1
Office of International Coop. and Devel.	6.6	5.3	5.0	0.7	5.5	5.3	5.4	3.1	2.5
Forest Service	95.0	95.9	108.4	112.1	107.7	108.7	113.8	113.6	125.8
Federal Grain Inspection Service	0.4	0.5	0.5	0.6	0.6	0.7	1.1	0.9	1.1
Total, research	648.2	687.5	778.0	816.3	856.6	884.6	968.6	943.8	1,005.9
<u>Education</u>									
<u>Extension Service</u>									
Smith-Lever 3(b&c) Formula	179.8	189.3	205.4	219.4	230.4	235.0	241.5	229.7	229.7
Other Extension Programs	77.5	78.2	80.7	90.0	92.8	93.8	96.8	93.1	96.5
Direct Federal Administration	6.5	6.5	6.1	6.3	5.4	5.5	5.4	5.2	6.0
Total, Extension Service	263.8	274.0	292.2	315.7	328.6	334.3	343.7	328.0	332.2
Cooperative State Research Service									
Bankhead-Jones	11.5	11.5	11.5	0.0	0.0	0.0	0.0	0.0	0.0
Morrill-Nelson	2.7	2.7	2.7	2.8	2.8	2.8	2.8	2.8	2.8
Competitive Fellowship Grants	0.0	0.0	0.0	0.0	0.0	5.0	5.0	2.9	2.9
1890 Colleges Grants	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.9	1.9
Total, CSRS	14.2	14.2	14.2	2.8	2.8	7.8	9.8	7.6	7.6
National Agricultural Library	7.0	7.3	8.2	8.2	9.1	10.4	11.5	10.8	11.1
Total, education	285.0	295.5	314.6	326.7	340.5	352.5	365.0	346.4	350.9
Total, research and education	933.2	983.0	1,092.6	1,143.0	1,197.1	1,237.1	1,333.6	1,290.2	1,356.8

^{1/} Reflects reductions under P.L. 99-177, the Balanced Budget and Emergency Deficit Control Act of 1985.

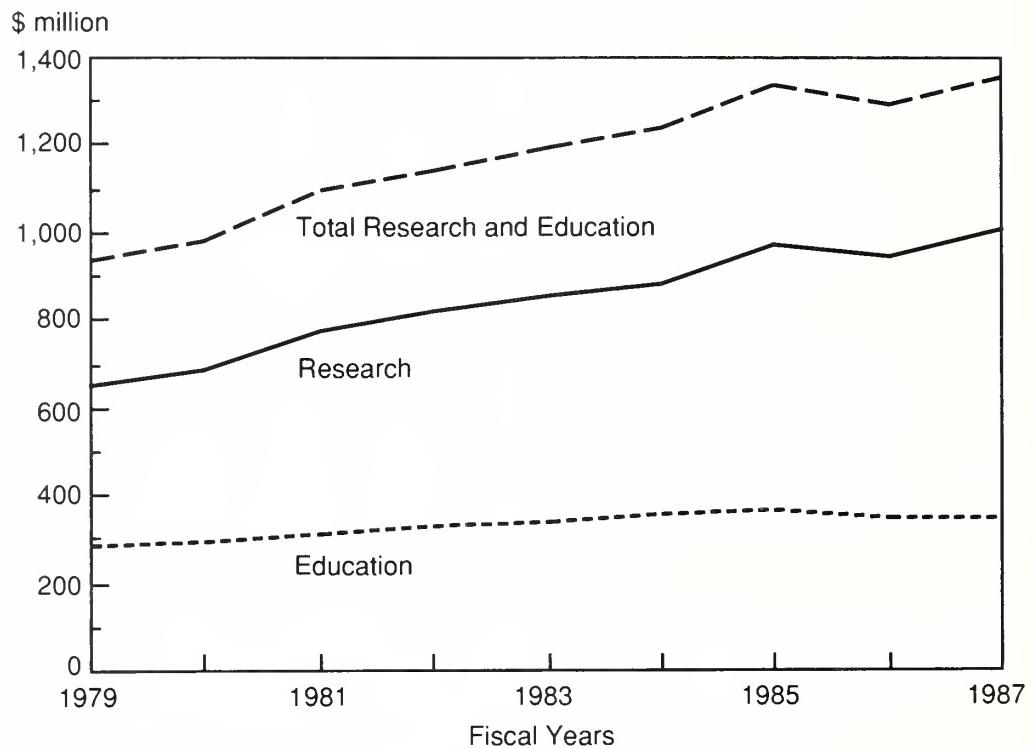
^{2/} Excludes ARS construction funding, which has been (in million of dollars): \$36.7 ('79), \$0 ('80), \$12.1 ('81), \$8.6 ('82), \$4.9 ('83), \$77.9 ('84), \$22.4 ('85), \$6.1 ('86), \$37.4 ('87).

^{3/} Excludes 1890 Colleges and Tuskegee Research Facilities funding, which has been \$10.0 million annually from FY 1983 through FY '85 and \$9.5 million each in FY '86 and FY '87.

Source: Office of Budget and Program Analysis (OBPA), USDA.

Figure 1.

USDA appropriations for research and education programs (current dollars), FY1979-87



Source: OBPA, USDA.

Table 2.

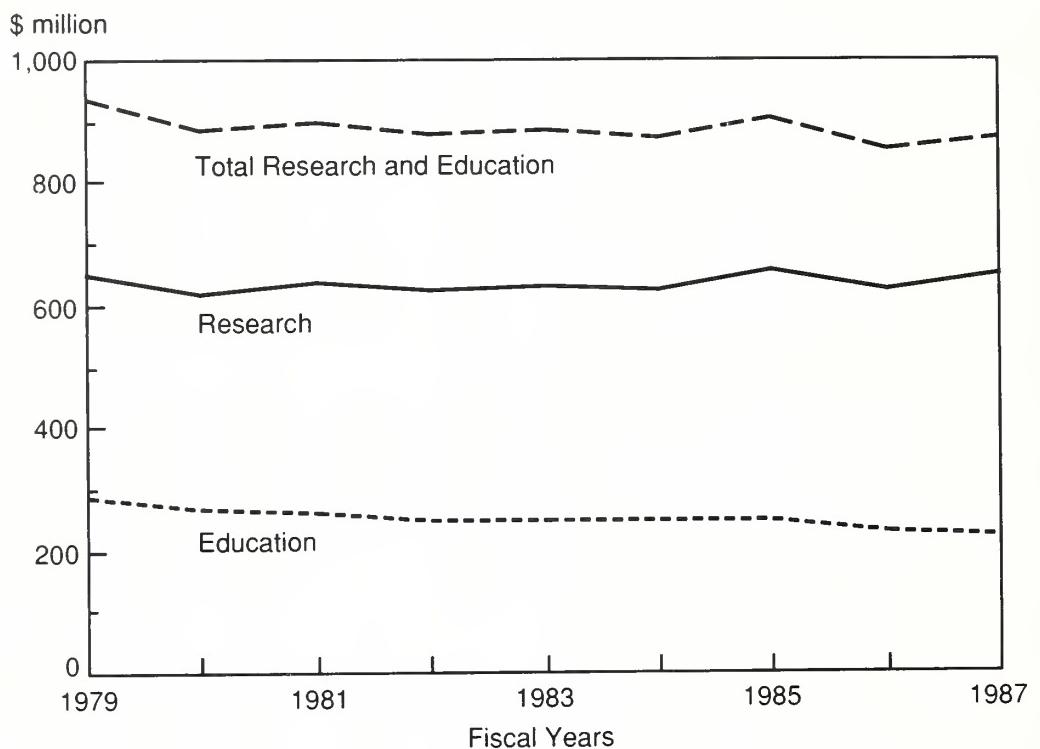
U.S. Department of Agriculture: Appropriations for research and education in constant 1979 dollars, FY 1979-87

Item	1979	1980	1981	1982	1983	1984	1985	1986	1987
<u>Research</u>									
Inflation rate		11.3%	9.2%	7.1%	4.0%	4.4%	4.1%	2.3%	3.2%
GNP deflator for gov't. purchases									
Index: (1982=100)	76.8	85.5	93.4	100.0	104.0	108.6	113.1	115.7	119.4
Agricultural Research Service									
Cooperative State Research Service									
Hatch Act Formula	109.1	106.5	105.7	108.4	108.7	107.7	106.3	98.8	95.7
Cooperative Forestry	9.5	9.0	8.9	9.2	9.2	9.0	8.9	8.2	8.0
1890 Colleges and Tuskegee	16.4	16.0	15.9	16.5	16.1	16.1	16.0	14.8	14.3
Special Research Grants	16.3	13.7	15.0	17.7	20.5	18.7	22.5	19.2	33.4
Competitive Research Grants	15.0	13.9	13.2	12.5	12.6	12.0	31.2	28.1	26.2
Rural Development Research	1.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Animal Health and Disease	5.0	5.4	5.3	4.5	4.3	4.1	3.9	3.7	3.5
Direct Federal Administration	1.5	1.2	1.1	0.6	0.2	0.4	1.0	1.0	1.7
Forestry Competitive Grants	0.0	0.0	0.0	0.0	0.0	0.0	5.3	4.3	2.9
Total, CSRS	174.3	167.0	165.0	169.4	171.5	168.1	195.2	178.1	185.8
National Agricultural Statistics Serv.	5.4	4.5	6.2	5.4	5.6	5.8	5.7	5.3	5.3
Economic Research Service	28.2	23.4	32.5	30.3	28.7	31.3	32.0	29.3	29.2
Human Nutrition Information Service	6.6	6.4	6.7	6.5	5.7	4.3	5.1	8.6	4.4
Animal and Plant Health Inspection Serv.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	3.0
Agricultural Cooperative Service	2.0	1.4	1.5	1.3	1.6	1.6	2.0	1.8	1.7
Agricultural Marketing Service	1.0	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0
Office of Transportation	0.7	0.7	0.7	0.8	0.6	0.6	0.9	0.7	0.7
Office of International Coop. and Devel.	6.6	4.8	4.1	0.5	4.1	3.7	3.7	2.1	1.6
Forest Service	95.0	86.1	89.1	86.1	79.5	76.9	77.3	75.4	80.9
Federal Grain Inspection Service	0.4	0.4	0.4	0.5	0.4	0.5	0.7	0.6	0.7
Total, research	648.2	617.5	639.7	626.9	632.6	625.6	657.7	626.5	647.0
<u>Education</u>									
Extension Service									
Smith-Lever 3(b&c) Formula	179.8	170.0	168.9	168.5	170.1	166.2	164.0	152.5	147.7
Other Extension Programs	77.5	70.2	66.4	69.1	68.5	66.3	65.7	61.8	62.1
Direct Federal Administration	6.5	5.8	5.0	4.8	4.0	3.9	3.7	3.5	3.9
Total, Extension Service	263.8	246.1	240.3	242.5	242.7	236.4	233.4	217.7	213.7
Cooperative State Research Service									
Bankhead-Jones	11.5	10.3	9.5	0.0	0.0	0.0	0.0	0.0	0.0
Morrill-Nelson	2.7	2.4	2.2	2.2	2.1	2.0	1.9	1.9	1.8
Competitive Fellowship Grants	0.0	0.0	0.0	0.0	0.0	3.5	3.4	1.9	1.9
1890 Colleges Grants	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.3	1.2
Total, CSRS	14.2	12.8	11.7	2.2	2.1	5.5	6.7	5.0	4.9
National Agricultural Library	7.0	6.6	6.7	6.3	6.7	7.4	7.8	7.2	7.1
Total, education	285.0	265.5	258.7	250.9	251.4	249.3	247.9	229.9	225.7
Total, research and education	933.2	862.9	896.4	877.8	884.0	874.9	905.6	856.4	872.7

Source: CBPA, USDA.

Figure 2.

USDA appropriations for research and education programs (constant 1979 dollars), FY1979-87



Source: OBPA, USDA.

Table 3.

U.S. Department of Agriculture: Percent changes in appropriations for research and education programs, by Agency, from FY 1979 to 1987 in constant 1979 and current dollars

<u>Agency</u>	Constant 1979 dollars	Current dollars
<u>Research</u>	<u>Percent</u>	<u>Percent</u>
Agricultural Research Service	- 1.4	+ 57.7
Cooperative State Research Service	+ 6.6	+ 65.7
National Agricultural Statistics Service	- 1.8	+ 51.8
Economic Research Service	+ 3.5	+ 61.0
Human Nutrition Information Service	-33.3	+ 4.5
Animal and Plant Health Inspection Service	N/A	---
Agricultural Cooperative Service	- 7.5	+ 35.0
Agricultural Marketing Service	0	+ 50.0
Office of Transportation	0	+ 50.0
Office of International Cooperation and Devel.	-75.8	- 62.1
Forest Service	-14.8	+ 32.4
Federal Grain Inspection Service	+75.0	+175.0
Total, research	<u>- 1.9</u>	<u>+ 55.1</u>
<u>Education</u>		
Extension Service	-19.0	+ 25.9
Cooperative State Research Service	-65.5	- 46.5
National Agricultural Library	+ 1.4	+ 58.6
Total, education	<u>-20.8</u>	<u>+ 23.1</u>
Total, research and education	- 6.5	+ 45.4

STATE AND COUNTY SUPPORT

State and county support for research and extension for the food, fiber, and forestry system at about \$1.4 billion per year is slightly higher than that of the Federal contribution of about \$1.3 billion. Combined Federal, State, and county funds support approximately 11,000 scientists and 17,000 extension personnel, who are the formulators and extenders of knowledge needed by the Nation's largest industry. Public investment in food and agriculture research and education has consistently provided annual returns of 30 percent or more.

State support for the food and agricultural sciences is provided primarily through the land-grant institutions (1862, 1890, forestry schools, and Tuskegee Institute) and includes funds for research, extension, and higher education. However, an estimated 50 State-supported, non-land-grant institutions also have agricultural programs. These programs are primarily devoted to higher education.

PRIVATE INDUSTRY RESEARCH AND DEVELOPMENT

The report "A Survey of U.S. Agricultural Research by Private Industry III" published in July 1985 by the Agricultural Research Institute (ARI) of Bethesda, MD, stated that "the best estimate of private industry annual expenditures in agricultural research (is) approximately 2.1 billion dollars."

Based on ARI data, industry overall is apparently devoting approximately 15 percent of its Research and Development expenditures to basic research, 43.5 percent to applied research, and 41.5 percent to developmental research. However, 62 percent of the companies responding to an ARI survey reported doing no basic research and 36.5 percent reported doing no research of any kind.

Major areas of research conducted by industry, as reported by ARI, are in pesticides, plant breeding, and human food. These three areas accounted for nearly two-thirds of the agricultural research carried on by industry.

SELECTED SIGNIFICANT ACTIVITIES AND ACCOMPLISHMENTS
IN THE FOOD AND AGRICULTURAL SCIENCES

AGRICULTURAL RESEARCH SERVICE

The Agricultural Research Service (ARS) conducts mission-oriented research to perpetually ensure an abundance of high-quality, nutritious, reasonably priced food and other agricultural products to meet domestic and world needs while maintaining environmental quality. ARS uses coordinated, interdisciplinary approaches in basic and applied research pertaining to soil and water conservation, plant productivity, animal productivity, commodity conversion delivery, human nutrition, and integration of agricultural systems.

Research is conducted at numerous locations in the United States, Puerto Rico, Virgin Islands, and several foreign countries. When appropriate, it is conducted in cooperation with the State agricultural experiment stations, other State and Federal agencies, private institutions, and industry.

Saline Water Use
for Irrigation
Successful

Research by ARS scientists demonstrated that saline drainage waters can be used to meet part of the water requirements of cotton. Water was applied in furrows in laser-leveled fields. Low salinity Colorado River water was used in the first irrigation to obtain good germination. Drainage water containing about 3.5 grams of salt per liter was used for subsequent irrigations on half of the plots. A cotton-cotton-wheat-alfalfa rotation with saline drainage water used after germination of the cotton plants and Colorado River water used during growth of the wheat and alfalfa kept yields of all crops at the same levels as when Colorado River water was used for all crops. Salinity in the soil at the end of the rotation was the same when saline drainage water was used on the cotton as when Colorado River water was used for all irrigations.

Ozone and Acid
Rain Effects
Measured

ARS studies have shown that ozone concentrations found in air in some locations reduce yields of cotton, corn, winter wheat, and soybeans. Yields of some soybean varieties were reduced by as much as 25 percent by ozone. Acid rain, at levels found in nature, has not injured trees or crops in any case studies to date in the United States.

Higher Rubber Yield From Guayule

Diversity found in yield and rubber content of guayule varieties indicates substantial potential for rubber production in the United States. Plots of diverse guayule breeding material established in 1982 were harvested and analyzed for rubber content and agronomic characteristics. Dry weight ranged from 0.03 to 4.79 kg per plant and rubber content from 2.2 to 9.4 percent. Such genetic diversity should enable a plant breeding program to increase rubber yield of guayule.

Lower Cost Surface Irrigation

Improvements in application uniformity of surface irrigation systems developed by ARS provide lower cost alternatives. Uniformity of infiltration has been increased by precise laser leveling or grading of land and automated water supply systems. These systems provide initially high and subsequently decreasing supply rates uniformly to each furrow or strip of land, supply intermittent flows, and thereby decrease infiltration at the inlet ends of fields that commonly absorb too much water. Farmers whose electrical power costs over 6 cents per kilowatt hour find that laser-leveled land and automated surface systems can reduce their operational costs by \$50 per acre per year compared to sprinkler systems.

Improved Grain Drill Will Help Reduce Soil Loss

Conservation tillage protects against soil erosion because it leaves residues on or near the soil surface. These residues prevent optimum plant use of conventionally applied fertilizers and cause poor seedling growth. Placement of banded nutrients below and to the side of the seed improves seedling vigor and efficiency of fertilizer use. A new grain drill opener developed by ARS precisely places seed and fertilizer in one operation. Over 250 farmers have requested information on this new opener. Two commercial drills offer this unique opener as an option. The new opener makes conservation tillage a more feasible practice for grain growers in the Pacific Northwest.

Long-Term Seed Viability at Lower Cost

Seeds of our major crops that are preserved in the National Seed Storage Laboratory deteriorate and must be regrown periodically to replenish the supply of viable seeds. Cryopreservation storage in liquid nitrogen extends the life of seed samples, reduces the number of times a seed type must be regrown, and the seed can be stored for one-fourth the current cost. The National Seed Storage Laboratory at Fort Collins, CO, is now preserving seeds of 34 major crops in liquid nitrogen vats.

Germplasm
From Iran
Provides Insect
Resistance

A new hard red winter wheat has been produced that is resistant to all known strains of the Hessian fly, the most destructive wheat pest worldwide. ARS and Kansas State University researchers transferred the resistance gene from a wild wheat collected in Iran in the 1950's. This research demonstrates the value of collecting wild germplasm from centers of origin and utilizing it to improve our cultivated crops.

Biocontrol
of Apple Storage
Diseases

Two apple storage diseases can now be controlled without chemical treatments. Botrytis and penicillium rots are two of the most important storage rot diseases of apples. ARS has discovered several microbes that reduce these rots when sprayed on the apples when they are put in long-term cold storage. Among them is a bacterium that provided 100 percent control of these diseases--the same as the chemical fungicide traditionally used.

Improved Soybean
Oil Quality

Progress is being made by ARS in developing new soybean varieties with improved oil flavor and stability. Crude soybean oil has both flavor and stability problems that have been overcome only by expensive processing steps. These problems are caused by the oxidation of the fatty acids in the soybean, especially linolenic acid. Scientists have reduced linolenic acid content from 9 to 3 percent and also identified lipoxygenase genes, which regulate the oxidation process. This research could lead to new soybean varieties whose oil is suited to specific cooking and industrial uses and thus lower processing costs.

Peanut Blight
Controlled
Biologically

Leaf spot blight disease of peanuts can be controlled with beneficial bacteria. This is one of the most important diseases of peanuts in the United States. Chemical pesticides are applied three to six times during the growing season every year to keep this disease under control. ARS has discovered two kinds of bacteria that, when applied six times during the summer, gave 75 percent control of this disease. One of the bacteria is already commercially available for other uses. This technology has the potential for reducing production costs while minimizing environmental pollution with chemicals.

Cloning Disease-
Resistant Peach
Trees

A peach tree has been produced that resists infection by a bacterial disease that causes black spots on the fruit and eventually kills the trees. ARS scientists have developed a tissue culture technique that makes possible the cloning of the resistant plant and the regeneration of large numbers of resistant seedlings for field trials. This technology can greatly shorten the time required to select for disease resistance, multiply desirable plant materials, and distribute them to growers.

Treated Grass
Seed Aids Range
Reseeding

Chemical treatment of range grass seed may facilitate reclamation projects in the arid West. In many western areas, the soil surface dries quickly after a rain and over 90 percent of the seeds scattered on the land for reseeding die just as they begin to sprout roots. In greenhouse tests, scientists used chemicals to reduce normal germination time of seeds from 7 days to about 24 hours. These chemical treatments for sprouting could significantly facilitate the successful reseeding and reclamation of overgrazed and unproductive rangeland.

Genetic
Engineering
in Chickens

ARS scientists have inserted artificially introduced avian leukosis viruses (ALV), and vectors made by recombinant DNA methods from ALV, into chickens. This was done by inoculating these viruses into fertile eggs near the partially developed embryo just before incubation, a very simple technique. The success probably depended on using an infectious virus that spread through the embryo and infected the progenitors of the reproductive cells. This method paves the way for utilizing ALV vectors for introducing cloned genes from any source into chicken chromosomes for use in the genetic improvement of poultry. Stable inheritance of the new inserted ALV DNA in successive generations has been shown. This sets the stage for advances in many research areas, such as genetically increasing resistance to disease and controlling growth and body composition.

First Sex
Chromosome
Selection

Preselection of sex in food-producing animals would increase the flexibility and efficiency of the livestock producer in the world's food need. Preselection of sex involves the manipulation of sperm because of their sex-determining function. Sperm from an animal model system, the chinchilla, were separated by ARS scientists into X- and Y-bearing sperm, using a special cell sorter, with 95 percent purity for each of the populations. This is the first time that X- and Y-bearing sperm were separated into two populations. This technique may lead to the identification of a surface marker peculiar to X or Y sperm populations, which could be useful in developing a practical means of sexing the billions of sperm needed for artificial insemination of domestic animals.

Fat Reduced in
Broilers

Diet restriction for a 6-day period early in life has been shown to reduce fat in market-aged broilers. ARS scientists were the first to describe the biochemical adaptation of chicks subjected to a regime that limits growth between 6 to 12 days of life. Six-day-old chicks were fed a diet that maintained their weight until they were 12 days old. On the 12th day after birth, all were placed on a normal diet designed to put on weight as quickly as possible. At market age (8 weeks), the chicks that had been fed the restricted diet for 6 days had 25 percent less abdominal fat and used less feed than those fed the normal diet throughout the 8-week period. A commercial system producing

leaner chickens will greatly reduce production costs and provide the consumer with leaner chicken.

New Vaccine
and Test for
Blood Disease
of Cattle

Anaplasmosis, a blood disease of cattle and sheep that is spread by ticks, costs the U.S. beef industry over \$100 million each year. ARS and cooperating State researchers have developed a "subunit" vaccine containing a specific protein from the surface of the parasite that induces neutralizing antibodies. In laboratory tests, the new vaccine appears promising. In addition, the gene coding for this surface protein has been cloned and used to detect infected ticks as well as chronically infected cattle.

Leaner, Lower
Calorie Beef

Low-calorie, low-fat beef products can be produced by selective breeding and processing techniques. ARS scientists found that the diverse breeds of cattle currently available for beef production, in combination with fat trimming techniques, could be used to provide an array of beef products that differ widely in fat and caloric content. Data from a cattle germplasm evaluation program (16 breeds) showed that the caloric content of closely trimmed (0.3 inch) boneless retail cuts of beef from the fatter breeds of cattle was 50 percent greater than thoroughly trimmed meat from the leaner breeds. A breeding program can be devised to match genetic potential with market opportunities for low-fat beef products, and still other factors important for efficient beef production can be considered.

An Industrial
Use for Corn

Starch plastic films made from surplus corn could replace plastic mulches currently in use, which are made only from petroleum-based chemicals. The black film protects tomatoes and other high-value crops from weeds and drought, extends the growing season by warming the soil earlier in the spring, and helps farmers produce an earlier crop at a good price. The plastic film's potential to biodegrade offsets a slightly higher cost and it should have an expanding market.

New Concepts
To Class Wheat

Many newly released wheat varieties do not have the traditional visual characteristics of their class. This can have an adverse effect on orderly marketing, domestic and export. Two prototype instruments developed by ARS scientists to measure the "hardness" or "softness" of single wheat kernels were provided the Federal Grain Inspection Service for evaluation. The single kernel approach is judged essential for determining mixtures. One instrument uses mathematical analysis of the "crushing curve"; the second separates hard and soft kernels based on how long the sound produced by grinding lasts. Soft kernels grind quicker than hard ones. Use of near-infrared technology to measure "hardness" of a bulk sample of ground wheat was confirmed by a collaborative study of all classes of wheat produced in the United States and integrated into the ARS wheat quality evaluation programs for breeders.

Biocontrol
Protects Stored
Peanuts

Moths and beetles that attack peanuts in warehouses are rapidly developing resistance to malathion and other chemicals. In one ARS study, two parasites, Trichogramma and Bracon wasps, used together reduced the number of Indianmeal and almond moths, the two major insect pests of stored peanuts, by 85 and 95 percent, respectively. These parasitic wasps offer a new approach for preventive control of moths and beetles.

Polytherm Fabrics
Both Warm and Cool

New polytherm fabrics of cotton, wool, or artificial fiber that warm you when you're cold and cool you when you're hot were developed by ARS scientists a few years ago. Now an improved process to treat fabrics overcomes an earlier problem, where the fabric treatment could not withstand laundering or exposure to moisture. Polyethylene glycols, which are durably bound to fabric, absorb and store heat when surrounding temperatures rise and then release heat when temperatures fall. Eventually, the treatment could be used on building insulation, draperies, and packaging materials and for aerospace and military applications. Licensing discussions are underway.

New Food Product
Uses Surplus
Milk and Rice

Nonfat dry milk, rice flour, and sugar, mixed with gums and a little vegetable oil, produce a nutritious and tasty food with the consistency of flan. Adding water heated for 3 minutes (boiling is not essential) to the mixture creates a new, instant dessert. Made without eggs, the custard-like product contains no cholesterol and is easily digested, with the gums acting as food fiber. Calorie content can be lowered by substituting artificial sweeteners for sugar. Changing the chemical composition of the lactose enzyme in nonfat dry milk to simple sugars makes the product available to lactose-intolerant consumers so they, too, can now benefit from all the nutrients of milk.

Corn Mold
Carrier
Identified

Soil-inhabiting beetles were found to be the major insect vectors of Aspergillus flavus, a mold on corn that produces aflatoxins harmful to livestock. The beetles feed on molded corn ears left in the field over winter and carry the initial A. flavus inoculum to developing corn ears, particularly to portions of the ear damaged by tunneling insect larvae, such as the corn earworm, or by birds. Production practices can now be developed to minimize the number of these soil beetles and the amount of aflatoxin production in corn.

Orange Juice
Flavor Components
Rapidly Identified

A rapid, new process has been developed by ARS for identifying the 21 major components that contribute to the flavor and aroma of single-strength orange juice. The process, which involves a combination of distillation and gas chromatography, can provide

processors with the data needed to bring the flavor of processed orange juice closer to that of freshly squeezed juice. It could also enable industry to identify the source of the off-flavors in juice and to correct or modify them.

Vitamin D
Deficiency
in Elderly

In a recent ARS study, 40 percent of the elderly entering a Boston hospital with fractured hips had little or no vitamin D in their blood. Decreased milk consumption and decreased exposure to the sun are the major causes. Vitamin D deficiency leads to reduced calcium absorption, compounding the bone loss due to osteoporosis and increasing the chance of hip and spine fractures in the elderly.

Calcium
Supplements
May Affect
Iron Intake

In a recent ARS study, less than half the radioactive iron added to a breakfast drink was absorbed when the subjects took 500 mg of supplemental calcium (62 percent of the Recommended Dietary Allowance) during the meal. Iron absorption was reduced equally by calcium phosphate and calcium carbonate. Absorption of zinc was not affected by the calcium supplement.

Refined Fiber
Lowers Cholesterol
But Not Mineral

ARS scientists discovered that dietary fiber lowered cholesterol without affecting mineral absorption. Four refined fibers used in processed foods were added to the diet of adult men, averaging 23 grams per day for 20 weeks. The study demonstrated that the dietary fibers that form gels could decrease serum cholesterol, a blood lipid associated with risk of coronary heart disease, without significantly affecting absorption of calcium, magnesium, iron, copper, or zinc. The results indicate that serum cholesterol can be lowered by dietary fibers that form gels without impairing mineral absorption.

Short Chain
Glucose for
Infants

Short chain glucose polymers make digestion easier for infants. An ARS study of 1-month-old infants showed that an enzyme secreted by their intestinal cells has a larger role in digesting glucose polymers than previously thought. The enzyme works best on short chains of glucose. Although healthy infants can handle the longer chains in infant formulas, premature infants and those with gastrointestinal problems have difficulty. Companies are now beginning to use the shorter polymers in infant formulas to make digestion easier.

Mothers' Milk
Used More
Efficiently

Formula-fed infants consume more energy (calories) than breast-fed infants. By 4 months of age, formula-fed babies consumed significantly higher amounts of energy than breast-fed infants, even though there was no apparent difference in weight gain. This appears to be explained on the basis that the protein and energy in mothers' milk are used more efficiently. These findings will help scientists adjust existing recommendations for formulas, some of which are based on theoretical estimates of energy needs.

**Robot in the
Laboratory
Doubles Output**

A tabletop robot is helping chemists assess the vitamin content of foods commonly eaten in the United States. The 2-foot-tall mechanical assistant takes over the tedious work of sample preparation, allowing chemists to double their daily output with more accuracy. Some of the nutrient values in USDA's food tables are calculated or inferred from measurements of other foods, and the foods available to consumers continue to change. Use of the robot is speeding this essential work.

**System for
Selecting Swine
Breeding Stock**

Swine breeders will soon be able to improve production efficiency with the help of a computer program called the Swine Testing and Genetic Evaluation System developed by ARS. It enables breeders of purebreds and prospective buyers of breeding stock to compare various genetic traits among animals in a herd. In a few years, with more data, comparisons may be made across herds.

**Computer Program
for Climatic
Information**

ARS scientists have developed a personal computer program to provide easy access to extensive climatic data. When the program is run, a State map appears on the screen, and the user can indicate the location wanted. The program can then provide rainfall probabilities in graphical or tabular form, or can simulate precipitation alone or in conjunction with maximum and minimum temperatures and solar radiation. This program will lead to improved designs of irrigation and drainage systems, heating and cooling systems, and provide input to models to permit natural resource management.

**Groundwater
Quality
Prediction**

Hydrology and erosion models and an improved pesticide model were linked together by ARS scientists to run as a single program. The model was developed to be easy to use and designed to operate on personal computers. Only about 45 seconds run time is required per year of simulation with eight pesticides. At present, 56 users from the Soil Conservation Service, Environmental Protection Agency, Extension Service, and State agencies and universities are applying the model and providing feedback to aid in further development and improvements.

COOPERATIVE STATE RESEARCH SERVICE

The mission of the Cooperative State Research Service (CSRS) is to advance science and technology in support of agriculture, forestry, people and communities in partnership with the State agricultural experiment station system, colleges, universities and other research organizations, and in consonance with the Secretary of Agriculture and the intent of Congress. Its scientists work with regional and national groups to assure the quality of science and to set research priorities. It administers USDA research funds appropriated by Congress for the States, gives focus to the broad programs of agricultural research in the States, and participates in a nationwide system of research planning and coordination.

State Cooperators

The programs of CSRS are carried out cooperatively with--

- o 58 State and territorial agricultural experiment stations
- o 17 colleges of 1890 including Tuskegee University
- o 28 schools of forestry
- o 29 colleges of veterinary medicine

Most of these institutions are associated with the land-grant universities. When all publicly supported agricultural research is considered, including all research agencies within the U.S. Department of Agriculture, two-thirds of the full-time equivalent scientist years are found in the State agricultural experiment station system. Because of shared responsibilities between research and teaching in the universities, the actual number of scientists is far larger. This provides a wide range of talent capable of addressing most kinds of problems faced by agriculture.

New Treatment for Cattle Eye Infections Developed

Researchers at Iowa State University have developed a prototype ring-shaped eye insert to release an antibiotic to treat microbial infections. The active ingredient of the hydrogel-coated polymer ring is tylosin, which is very effective in combating microbial infections that can otherwise lead to severe eye infections and blindness in cattle. Laboratory work has shown that the required levels of drugs are released over several days, and consequently field use of such a system may offer an inexpensive and effective way to reduce the yearly multimillion-dollar losses to the cattle industry due to keratoconjunctivitis.

Utilization of
Lignin

Researchers at the Mississippi State University Forest Products Laboratory have developed an oxidative-depolymerization scheme that converts the somewhat intractable lignin molecules from biomass conversion and pulping into a more reactive form that can be used as a starting material to produce a variety of industrial chemicals. Among the potential products is a vanillin, currently manufactured from lignin for use as a food additive and in manufacture of medicine. Others include various polymeric products, such as phenolic adhesives and polyesters.

Baby Pig
Mortality

In the United States, 20-30 percent of the pigs farrowed die between birth and weaning. This high level of mortality is due largely to the metabolic instability of the newborn pig. Animal nutritionists at the University of Kentucky have developed a nutritional regime for the pregnant sow that reduces baby pig mortality by 5 percentage units. The inclusion of 1,3-butanediol, a synthetic energy source in the sow's diet during the last 10 days of pregnancy, has been shown to improve the metabolic stability of the young pig and to reduce the number of pigs that die in each litter by 0.5 to 0.6 pig (from 2.4 to 1.8 pigs per litter). In the United States, this represents a potential savings of 5 million pigs annually (10 million litters per year x 0.5 pig saved per litter). The use of 1,3-butanediol as a feed supplement for pigs is currently being evaluated by the Food and Drug Administration.

Ethanol
Production

The use of surplus crop commodities for nonfood industrial purposes is limited by commodity and processing costs. In ethanol production from corn, the cost of dehydrating 95 percent ethanol to produce anhydrous, fuel-grade ethanol is substantial. Purdue University researchers have developed a process, using corn as an absorbent, that reduces this cost by three-fourths. Alcohol-water vapor is passed through a bed of dried ground corn at 80°C. Water is selectively removed by the corn, allowing anhydrous ethanol to be recovered. The corn bed can be easily redried and reused.

New Plant Source
for Industrial
Chemicals

Crambe, a bushy, mustard-like plant, has the potential to become a U.S. replacement for imported sources of erucic acid. Erucic acid is essential to industrial processes like continuous steel casting and nylon and plastic production. U.S. industries that need this acid have depended mainly on imports from Canada and Poland. Researchers at the Iowa Agriculture and Home Economics Experiment Station have found that Iowa's climate and growing conditions are ideal for crambe production and that yield potential is high and production costs are relatively low. The research is one of the Iowa Station's newest efforts, and it has generated considerable interest among Iowa farmers who are ready to be pioneers in developing a crop with a dependable market and long-term guaranteed price.

Disease-Resistant
Wheat Varieties

A 25-year project in wheat breeding at the University of Nebraska has resulted in developing 25 new disease-resistant hard red winter wheat varieties that account for 90 percent of the Nebraska wheat acreage, 40 percent of all U.S. hard red wheat acreage, and over 20 percent of all U.S. wheat acreage. These improved varieties contributed at least 23 million additional bushels annually during the period of the project, providing additional annual farm income of \$100 million in Nebraska alone. Because they possess effective resistance to stem rust, the most dangerous wheat disease in Nebraska, together with improved resistance to lodging, these varieties have contributed significantly to the stability of wheat production and of U.S. agriculture. In addition, the germplasm in varieties from the project is a prominent parental material in most hard red winter wheat varieties of the Great Plains.

New Vaccine for
Control of Foot
Rot in Sheep

Foot infection caused by a bacteria, Bacteroides nodosus, is the major disease affecting sheep in the Western States and is a continuing problem in other areas of the country. Foot rot outbreaks in western range flocks have been estimated to cost as much as \$18 per ewe per year. Colorado scientists have completed the evaluation of a new vaccine in 500 ewes. The results clearly indicate that the severity of the disease was decreased in vaccinated animals, whereas in the controls the disease became worse during the test period. These results indicate that vaccination is a management tool that will help producers in their efforts to control and possibly eradicate foot rot due to B. nodosus. Studies are continuing to determine whether there may be different serotypes of the causative organism for which the vaccine may be less effective.

Assurance of Safety
for In Vitro Fertil-
ization of Embryos

Questions have been raised whether genetic abnormalities might be incurred during laboratory fertilization of embryos, a process used with increasing frequency in animals and people. Scientists at Michigan State University have completed the first and only study thus far to assess the possibility of chromosomal damage during in vitro fertilization of nonhuman primate embryos. Chromosomal abnormalities were found to occur at the same rate as in naturally fertilized embryos. Thus, there is no evidence to suggest a higher incidence of birth defects in embryos produced by in vitro fertilization. This finding has immediate application to the increasing research and commercial interest in this process in livestock and to the use of the process in humans.

NATIONAL AGRICULTURAL STATISTICS SERVICE

The National Agricultural Statistics Service (NASS) conducts research to improve the statistical methods and techniques used to produce agricultural statistics. This research is done in support of the NASS long-range program for improving the accuracy of crop and livestock estimates at minimum cost and is directed toward better sampling, yield forecasting, and survey techniques.

Objective Yield Research and Analysis

Emphasis has been in the areas of quality assessment and improvements in statistical methodology. Data quality and sampling procedure research included several studies to determine potential plot location biases, a study of laboratory processing errors, an evaluation of an alternative method for maturity code determinations in corn, and an evaluation of enumerator fatigue and plant handling effects.

Statistical methodology studies produced recommendations for improved test statistics for forecast and estimate research; an alternative, simplified soybean estimator; improved sunflower forecast models; and analyzing data from the complex objective yield survey design. Ongoing research efforts and analysis techniques started in FY '86 are evaluation of the power of research test statistics, evaluation of plot-level data collection and editing procedures, effect of cropping practice changes on sampling methods and forecasting, use of covariance models, use of year as a random effect in regression models, evaluation of an improved early forecast model for corn ear weight using weather data, evaluation of a State-level corn production forecast model, and development of a probability-based model to predict corn yields.

Plant Growth Simulation Modeling

Research on plant growth process simulation models as candidates for supplementing the present yield forecasting system has been unsuccessful. Growth simulation models are structured with functional relationships representing growth of the plant. Initial evaluation and efforts to validate the soybean and cotton model with existing data sets are underway. Computer analysis systems have been developed to evaluate the potential of process models for forecasting. Research papers covering the process model analysis and final validation efforts are being prepared. Model development for all crops has been deemphasized until more basic plant research is completed by university investigators.

Computer-Assisted Telephone Interviewing (CATI) Research	CATI software was written to support a series of research studies dealing with the proper use of historical survey data in the current interview. The major recommendation was to use historical data during the current interview primarily as an editing tool. Additional CATI research is being conducted in conjunction with the Quarterly Agricultural Surveys on optimal calling schedules. A cooperative agreement with Oklahoma State University is designed to determine times at which optimal response is obtained, calling schedules for the CATI automatic scheduler, and other manual CATI calling routines.
	Inforex computers were installed in 13 State Statistical Offices (SSO's) during FY '86, bringing the total SSO's to 15. Training schools were conducted in Nashville, TN, and Washington, DC, to instruct SSO's in the operational usage of CATI software on the Inforex. Since June 1986 these SSO's have been using CATI telephone interviewing for the Quarterly Agricultural Surveys, the monthly Milk Production Survey, the Quarterly Farm Labor Survey, and List Sampling Frame criteria questionnaires. Implementation of CATI has had a major impact on improved data quality by ensuring consistent data collection across all CATI facilities.
Nonresponse Estimation	Research was conducted to evaluate alternative methods of imputing for nonrespondents in crop and livestock surveys. The research findings would help formulate the imputation strategy for the Quarterly Agricultural Surveys. A staff report is available that presents the research analysis and findings.
Robust Estimation	A cooperative research agreement was initiated with the Statistics Department at Oregon State University to investigate robust estimation procedures best suited for agricultural surveys. These procedures adjust for outlier data that distort survey results. The theoretical framework was developed and preliminary analysis started.
Sample Rotation Effects	Survey data from the list frame were analyzed to gain insight into whether survey responses differ between farm operators who had been contacted for other agricultural surveys during the year and operators who had not. This is referred to as sample rotation effects. The analysis did not uncover a pattern of rotation effects. The results have been documented.
Area Frame Estimation	Data to evaluate a commodity weighted estimator were collected and are currently being analyzed. This estimator shows potential to be less biased than the current weighted estimator. Weighted estimators are worthwhile research topics because they are theoretically one of the lowest variance livestock estimators, but they have exhibited the largest bias in operation.

**Area Frame
Construction
Research**

Stratification for area frames is a process of dividing the land areas in a State into different land-use categories or strata to increase sampling efficiency. Stratification is currently performed using aerial photography and Landsat imagery. A study was conducted in selected counties in Florida and Wyoming to make a preliminary evaluation of using digital Landsat data as the sole stratification source during area frame development. The small-scale study was somewhat encouraging, given the limitations of the study design. A staff report is available that describes this project.

At the end of FY '86, a cooperative research agreement was signed with the Center for Remote Sensing at Michigan State University to investigate the use of geographic information systems to improve the stratification process for area frame development.

Work began on developing software to provide the capability of constructing area frames using automated rather than the traditional manual procedures. The automated concept uses input such as Landsat data and digital line graph data (digitized road networks, railroads, water bodies, etc.) on a graphics work station to develop an area frame.

Sample Integration

The economic surveys use a different area frame sample than the crop and livestock surveys. This is because a different estimation method and sampling unit size are used. Research commenced in 1986 to study the feasibility of integrating these surveys on the same area frame sample. Initial results were promising and have led to a more indepth study in 1987.

**Small Area
Estimation
Research**

Research continued on the development of a model-based procedure that uses historical and current data to make district and county estimates. Analyses were completed for North Carolina and California acreage estimates. Procedures were developed to account for data incompleteness. Results were not successful and thus create a reevaluation of this technique and research direction.

**Integrated Survey
Project (ISP)
Research**

Several areas of research were or are underway to evaluate data collected in the ISP States. An analysis was completed on comparison of the tract, farm, and weighted direct expansion estimators. Nonsampling errors associated with the estimator were evaluated and survey cost data were summarized with comparisons by State. Research also included development of a revised stratification design with multivariate procedures recommended to determine strata and sample allocations. Analysis of poststratified hog data were completed in one State. The evaluation of sample rotation and potential biases

Research To
Develop
Methodology for
Using Satellite
Data

is continuing. Imputation procedures and methods for handling previously reported data are also being studied. In addition, investigation of procedures to handle outliers or atypical reporting units is underway.

In 1986, Landsat multispectral scanner data were used with NASS ground-collected data to calculate improved crop area estimates at the State and county levels in Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Missouri, and Oklahoma. Data were obtained from both Landsat 4 and 5 and resulted in much better coverage in the major producing agricultural areas. Data from two satellite overpass dates were combined to provide increased precision in several States. Estimates for planted and harvested acreage of winter wheat were obtained in Colorado, Kansas, Missouri, and Oklahoma. Planted acreage estimates were obtained for rice, corn, sorghum, cotton, and soybeans in Missouri; rice, sorghum, cotton, and soybeans in Arkansas; and corn and soybeans in Illinois, Indiana, and Iowa.

In 1986, work was completed on the conversion of the satellite data analysis programs to one portable language. This conversion will facilitate the transfer of these programs to other computer systems. The analysis system has already been transferred to another main-frame computer and a microcomputer system. Work has begun on transferring parts of the system to desktop personal computers.

NASS has entered into an agreement with the French Ministry of Agriculture to conduct joint research on the newly available SPOT data. In this agreement, NASS provided the French Government the satellite data analysis programs in exchange for SPOT data in western Kansas. Research will begin on the use of advanced sensor data available from the SPOT satellite as well as Thematic Mapper data available from the Landsat satellites. This research will be a first step in the use of higher resolution satellite data in crop area estimation.

Research on statistical methodology, data processing including both hardware and software, automation, and other techniques to increase efficiencies continued in 1986. Major developments included improved batch data processing capabilities, improved file transfer methods, and standardization of analysis steps.

ECONOMIC RESEARCH SERVICE

The Economic Research Service (ERS) produces economic and other social science information as a service to the general public and to aid the Congress and the Executive Branch in developing, administering, and evaluating agricultural and rural policies and programs. ERS monitors, analyzes, and forecasts U.S. and world agricultural production and demand for production resources, agricultural commodities, and food and fiber products. ERS also measures the costs of and returns to agricultural production and marketing; evaluates the economic performance of U.S. agricultural production and marketing; and estimates the effects of Government policies and programs on farmers, rural residents and communities, natural resources, and the American public in general. In addition, ERS produces economic and other social science information about the organization and institutions of the U.S. and world agricultural production and marketing systems, natural resources, and rural communities.

ERS-produced information is made widely available to the general public through research monographs, situation and outlook reports, professional and trade journals (including ERS's journal, Agricultural Economics Research), magazines (including ERS's magazines, Agricultural Outlook, Farmline, National Food Review, and Rural Development Perspectives), radio, television, newspapers, direct computer access, and frequent participation of ERS staff at various public forums.

Rural Banks
More Likely
To Fail

ERS analysts found that commercial banks in counties dependent on farming and mining have an elevated probability of failure. The banks can reduce the problem by diversifying loan portfolios and limiting credit risks.

Farm Financial
Stress on Rural
Governments
Studied

In an ERS study, declining tax revenues from farm properties and related businesses were found to contribute to extreme financial stress of some local governments. Tax delinquencies were also high, and important public services face reductions. The effects may continue for several years.

Financial
Data Series
Improved

ERS adjusted its data collection program to provide more concise information on net earnings and financial characteristics of farming units by type, size, and location. The information will allow statistically sound estimates in identifying farmers encountering financial problems and analyses of the amount of debt at risk of loss to lenders.

Exchange Rates and Farm Trade Closely Tied	Exchange rates have a significant impact on U.S. farm trade and competitiveness, according to ERS researchers. Adjustments to exchange rate changes are generally spread over a 3-year period, however. The exchange rates are more important to U.S. agricultural trade than foreign economic activity, whereas U.S. loan rates and target prices are twice as important as exchange rates.
Reports on How Government Policies Affect Trade	Intervention by governments makes agricultural trade less responsive to international price changes than would happen otherwise. For example, changes in Mexican Government policy and weather were more important than changes in world prices in determining our import volumes.
Export Demand Variables Evaluated	ERS evaluated the relative importance of foreign income, foreign exchange reserves, U.S. price, competitor price, and exchange rates in determining demand for U.S. corn and soybeans. The researchers found that for corn, foreign production and the U.S. corn price were the most important variables. For soybeans, the key variables were importers' income growth rates and the U.S. soybean price.
Foreign Fruit, Vegetable, and Potato Competition Studied	Mexican growers have expanded their share of the U.S. winter fresh fruit and vegetable market at the expense of Florida products, ERS researchers found. Helped by periodic peso devaluations, Mexican growers held a competitive edge in five of the six commodities studied. For fresh potatoes, Canada provides only a share of U.S. use but reached new highs between 1980 and 1984, when the U.S. dollar appreciated vis-a-vis the Canadian dollar.
Database Developed	ERS economists have developed a database on foreign government interventions in the production, consumption, and trade of agricultural products. Information on a wide selection of policies and programs has been compiled and electronically stored.
Food Demand Researched	The principal factors contributing to year-to-year changes in per capita consumption of individual commodities are changes in relative prices and consumer incomes, ERS research confirmed. In the longer term, higher consumer incomes, followed by population growth, are the most important factors, with aging of the population and regional population composition less important.

**Impact of
Production Inputs
Reviewed**

The availability and costs of inputs--fertilizers, pesticides, farm machinery, and fuel--affect both farmers and consumers, according to ERS analysts. For example, because crude oil prices declined sharply in 1986, farmers' production costs for fuel decreased from 22 cents per acre for soybeans to \$1.64 per acre for peanuts, with aggregate annual savings well over \$1 billion. Removing certain corn and soybean pesticides from the market could increase U.S. agricultural production costs, crop prices, farm incomes, and consumer expenditures.

**Land Value Decline
Tracked**

U.S. farmland values fell an average of 12 percent between April 1985 and February 1986. The decline, which began in 1981, reflects low commodity prices, low export demand, high interest rates, and a cautious outlook by farm investors. ERS projects that farmland values will decline further in 1987, though at a slower rate than in 1986. In 1988, values may begin to level off and even rise if investors start to expect increasing returns to land.

**Soil
Conservation
Program Evaluated**

ERS found that soil conservation benefits could be increased if programs were directed more toward controlling erosion on highly erodible land. On average, the benefits of erosion control measures exceed their costs only on land with erosion above 15 tons per acre per year. Yet, a significant share of conservation expenditures has been directed to cropland eroding at less than 5 tons per acre annually.

**Change in
Population Shift
Identified**

The "rural turnaround" of the 1970's, in which job and population growth rates in rural areas exceeded those in urban areas, has reversed again, ERS analysts discovered. Now urban growth rates again exceed rural ones. Many rural areas have not recovered from the goods-producing recession of the early 1980's, others have been adversely affected by declining mining and oil industries, and others have been hurt by the farm financial situation.

AGRICULTURAL COOPERATIVE SERVICE

The Agricultural Cooperative Service (ACS) provides research, technical assistance, and information and education for development of cooperatives as farmers' extension into the marketplace. The Agency is the information source within Government when issues of policy, legislation, or regulation concerning farmer cooperatives arise.

1985 Ag Co-op
Business Volume
Lowest in 6
Years

Combined business volume of 5,625 agricultural marketing, purchasing, and service cooperatives for 1985 was \$64 billion, down 12 percent from 1984 and the lowest in 6 years. Net margins of \$767 million in 1985 represented a 23-percent decrease from 1984. Total assets of farmer cooperatives fell 4.8 percent in 1985 to \$27.8 billion, whereas member patron equity was off slightly from \$12.2 billion to \$12.1 billion. Cooperative memberships were down less than 1 percent to 4.8 million in 1985.

Top Co-ops
Sales, Margins,
Assets, Debt
Down

Sales of the 100 largest farmer cooperatives dropped almost 11 percent from \$52.8 billion in 1984 to \$47.2 billion in 1985. Net margins fell sharply from \$430 million in 1984 to \$241 million in 1985, a 44-percent drop. Assets of the top 100 fell 4.6 percent to \$15.8 billion, whereas their total debt was reduced 7.2 percent to \$5.9 billion.

Fertilizer
Manufacturing
and Marketing
Highlighted

Research documenting fertilizer manufacturing and marketing activities of regional and interregional cooperatives in the United States was completed in 1986. The resulting database includes information on sales, market shares, production, capacity, inputs, and markets for the largest 24 regional and interregional cooperatives handling fertilizer.

Co-op Financial
Instruments
Analyzed

Financial instruments unique to cooperatives (retained patronage refunds and per-unit capital retains) and those available for use by noncooperative business corporations were analyzed. Rights and liabilities of the cooperative as issuer and the farmer-investor as owner and user of the cooperative are discussed, as are problems associated with equity redemption.

Farm Supply
Outlet
Consolidation
Evaluated

Operating costs and key operating parameters are identified in this study of advantages and disadvantages of farm supply outlet consolidation. Key variables are incorporated into an economic optimization model for computer analysis of alternative outlet designs.

Fluid Milk
Packaging Costs
Studied

Costs of various functions performed in 15 fluid milk plants were studied. This research was designed to help develop analytical methods for plants to isolate and resolve cost problem areas in operations from both internal analysis and external comparisons; develop new industry cost curves illustrating economies of scale; and as a service to participants through provision of comparative cost analyses.

Export
Opportunities
for Co-ops

Information is provided for west coast cooperatives on the potential for expanding exports of processed fruit and vegetables to the retail food trade in Pacific Rim countries. Specific market opportunities and ways cooperatives may develop them are identified.

Livestock
Marketing Co-ops
Studied

An evaluation was made of the services and marketing strategies of cooperatives marketing live animals relative to industry trends and needs of producer members. The study is based on a survey of 868 producers and 17 cooperative managers.

Helping
Low-Resource
Farmers Raise
Equity Capital

Basic problems confronting four Louisiana vegetable marketing cooperatives organized to serve low-resource farmers are examined. These problems include too few producers and farm size too small to support a viable cooperative. The study aims to identify alternatives for low-resource farmers to raise equity capital necessary to support a cooperative.

Technical
Assistance
and
Education

ACS was involved in 66 formal technical assistance projects in 1986, of which 48 were for emerging and developing cooperatives representing more than 5,200 farmers and a wide range of commodities. A number of projects involved merger, consolidation, divestment, and alternatives to traditional row crops. One study developed criteria by which cooperatives and their farmer members could receive more than \$2 billion in refunds from overcharges on stripper well fields. Other projects included a merger feasibility study of Midwest dairy cooperatives; cost analysis for cooperatives of major approaches being examined for refinancing the environmental cleanup Superfund; and feasibility of developing new cooperatives to handle fruits and vegetables, dairy goats, orchids, handicrafts, and other commodities.

ACS responded to 2,237 requests for information and distributed 82,506 publications. The Agency continued its role in providing cooperative education to the international cooperative community in 1986, hosting more than 200 foreign visitors.

ANIMAL AND PLANT HEALTH INSPECTION SERVICE

The Animal and Plant Health Inspection Service (APHIS) has an Animal Damage Control (ADC) Program through the Denver Wildlife Research Center (DWRC). This program is responsible for conducting research to develop new knowledge necessary to combat vertebrate pests destroying America's agricultural products. The research provides knowledge and tools to reduce wildlife conflicts with agriculture and transfers existing technology to broader uses in animal damage control. Collecting scientific information for new, and maintenance of existing, chemical registrations is a major task.

Bird Behavior Study Aids Control

Examination of starling foraging behavior near three large blackbird-starling winter roosts in the Southeastern United States showed that prebaiting and use of livestock decoys can attract starlings to preroosting foraging sites. Toxic baits can then be used to kill attracted birds and reduce agricultural damage.

Reregistration of Agricultural Rodenticides

Data essential to reregister seven zinc phosphide formulations were given to the Environmental Protection Agency (EPA) along with data on storage stability of the formulations. Initial data required for registration of 0.35 percent and 0.50 percent strychnine concentrations for controlling eight species of ground squirrels were also submitted to EPA.

Baiting Research for Coyote Control

Use of baits for selective coyote control potentially offers an inexpensive means of reducing predation on sheep and other livestock. Field and pen studies to improve coyote acceptance of small baits were conducted in Texas, Idaho, and Utah. Physiological marking agents were developed and incorporated in baits to simulate the use of toxicants or other chemicals in the field. Bait placement and bait density variables are being studied by recovering scats or analyzing coyote blood to determine proportions of local populations that consumed baits. Marking trials indicated that up to 30 percent of the coyotes consumed small baits in field applications; current work seeks ways to substantially increase this percentage.

Statistical Improvement of Biological Assays

New statistical techniques for improved handling of small sample biological assays were published. Guidance is provided on appropriate estimators to use for LD₅₀ and LD₉₀ computations and minimum sample size and numbers of dose levels for particular situations. These findings will reduce the cost to USDA in meeting EPA requirements for chemical registration.

Forest Regeneration Aided	Mountain beavers that destroy young pine seedlings in regenerating forest stands on public lands in Washington and Oregon are repelled by "Big Game Repellent Powder." Conditioned and nonconditioned mountain beavers were provided the powder. Strong repellency occurred with the conditioned animals. Field tests will determine the effectiveness of the powder to protect seedlings planted at high cost on steep slopes in areas inhabited by mountain beavers.
Electronic Enhancement for Research	Improved design and miniaturization of radio transmitters have enhanced the ability of researchers to obtain essential information on the field efficacy of both lethal and nonlethal control methods. First steps were taken to convert electronic equipment production to a new process called surface mount technology as a further effort to greatly improve transmitters. Cooperative research was continued with the NASA Kennedy Space Center on automated tracking systems.
Physiological Studies With Birds	The combination of prerecorded distress sounds and sublethal doses of central nervous system stimulants, including strychnine, caffeine, and theophylline sulfate, causes strong reactions in birds. The results indicate a potential for enhancing the effectiveness of using sound when combined with sublethal chemical applications.
	Research sponsored by the U.S. Department of Defense is underway on behavioral and physiological effects of phosphorous smoke inhalation on prairie dogs and rock doves. This contract research has potential spinoff for improving bird control methods using a smoke carrier to deliver a chemical.
Sensory Investigations of DMA as Bird Repellent	Chemosensory assessment has shown that dimethylanthranilate (DMA) is repellent to birds at feedlots. By testing the repellency of nine chemical homologs of DMA, repellency was shown to be correlated with steric or electrical obscuration of the amine fraction of the anthranilate molecule. Birds with bilateral olfactory nerve cuts continue to reject DMA and its homologs, although food consumption is significantly increased. The finding demonstrates that anthranilate avoidance in birds is not mediated by the olfactory system as it is in mammals. Studies also found that anthocyanins extracted from grape skins are repellent to starlings at low concentrations.
Biotechnology Applied to Bird Damage	Cooperative studies continued to develop plant resistance to bird depredations. Scientists at the University of Arkansas, North Dakota State University, and DWRC are combining efforts to determine the phenotypic and chemical characteristics that reduce or deny bird access to corn, sorghum, and sunflower seeds. Several varieties and characteristics are being tested in the field and laboratory.

Bird Hazards
to Aircraft

Scientists at DWRC evaluated an approach to reduce bird-aircraft interactions at military airfields. Surveys conducted under contract at two Navy airfields in Texas resulted in a determination of hazards and a listing of recommended agricultural crops and practices to minimize adverse interactions between birds and aircraft.

Sheep Protection
on Public Lands

Field trials of multistimulus frightening devices to protect sheep from coyote predation on bed-grounds were continued on summer grazing allotments on public lands in mountainous areas of Colorado, where use of existing predation control methods is either limited or impractical. These portable devices produce a light and high frequency sound randomly throughout the night and appear effective in reducing coyote activity near bed-grounds without disturbing the sheep.

Coyote
Vulnerability

Studies of female coyote behavior with radio-telemetry showed that animals were more vulnerable to capture when outside their territories. Almost one-half of 47 instrumented females were transients. Both transient and out-of-territory coyotes tended to move through spaces between occupied territories; capture efficiency increased fivefold in these areas. This increased vulnerability of coyotes outside their territories has potential application for improving efficiency and selectivity of other control methods.

HUMAN NUTRITION INFORMATION SERVICE

The Human Nutrition Information Service (HNIS) develops, through applied research, information required to improve public understanding of the nutritive value of foods, the nutritional adequacy of food supplies and diets, and the selection of nutritious and healthful diets. The Agency compiles food composition information, monitors food and nutrient consumption by U.S. households and individuals through national surveys, and develops materials and techniques to help Americans improve their nutrition and reduce risk of disease through better diets.

Data on Nutrient Content of Beef Revised

The revised section on beef products (AH 8-13) in Agriculture Handbook No. 8, "Composition of Foods," was published. These data are critical to the meat industry as they begin to market beef to a public growing increasingly conscious of the nutritional attributes of various foods. Also published was the section on beverages (AH 8-14).

Nutrient Data File Released

A computerized data file of the content of 27 food components in each of 4,700 foods compiled by Agency scientists was released for use by researchers and others in calculating the nutrient content of diets. Provisional data were released on other food components of nutritional interest--Omega-3 fatty acids, vitamin K, and sugar.

Eating Behavior and Nutrient Levels Described

National food consumption surveys in 1985, and again in 1986, of sample populations of women and young children for 6 days spread over the year provide evidence of dietary change--less meat, eggs, and whole milk; more low-fat milk, grain products, and soft drinks--since the last large decennial Nationwide Food Consumption Survey in 1977-78. Analysis of 1985 data to identify factors affecting food consumption behavior and nutrient levels was undertaken with eight research teams in six universities.

National Nutrition Monitoring Data Interpreted

"Nutrition Monitoring in the United States," released in July 1986, integrates and interprets for Congress information from the National Nutrition Monitoring System. Prepared by an expert committee with major technical support from HNIS and the National Center for Health Statistics, Department of Health and Human Services (DHHS), this report identifies nutrition-related inadequacies and excesses of food components of public health concern.

Decennial Food Consumption Survey Planned

The Nationwide Food Consumption Survey 1987-88 was planned, with data collection scheduled to begin in April 1987. Plans incorporate improved methodologies and coordination with DHHS's National Health and Nutrition Examination Survey, which is to begin in 1988.

Dietary Guidelines Promoted

A series of seven short bulletins was published to guide the public in putting the USDA-DHHS "Dietary Guidelines for Americans" into practice. The format of the bulletins reflected findings from USDA-sponsored nutrition education research.

Cost of Food at Home Published

The cost of four USDA family food plans--thrifty, low-cost, moderate-cost, and liberal--was released monthly. A bulletin, "Thrifty Meals for Two," was published to help older adults manage at the thrifty food plan cost level.

Nutrients in Food Supply Estimated

Estimates of the nutrient content of the 1985 food supply were added to the historical series of annual estimates, beginning with 1909. Also, a special study of the nutrient content of the Russian food supply was conducted with the Central Intelligence Agency.

AGRICULTURAL MARKETING SERVICE

The mission of the Agricultural Marketing Service (AMS) is to stimulate competition and to increase efficiency in the marketing of agricultural products. The Agency's research activity includes conducting marketing surveys and analyses to determine needs for marketing and processing facilities; designing such facilities; and conducting studies to improve the marketing, handling, processing, and distribution of agricultural products. An important part of this program is the assistance provided to State and local governments and industry groups in market development activities.

Market Development Plans for Buffalo, NY

Cooperating with the New York Department of Agriculture and Markets, AMS researchers have developed plans and assessed alternatives for a combined wholesale food distribution center and farmers' market to serve the Buffalo, NY, area. Depending on the site plan and financial arrangement selected, the new center would require between 80 and 110 acres and cost from \$19.4 million to \$28.4 million. As a basis for planning, researchers surveyed 166 wholesale firms along with a selected sample of produce grower-shippers and present users of the major existing farmers' market in an 8-county study area.

Long-Range Planning for Maryland Wholesale Food Center

A study of current operations and the potential for further development of the 398-acre Wholesale Food Center at Jessup, MD, has been undertaken in cooperation with the Food Center Authority, a State agency governing the market. This important market serves Baltimore, MD, and the surrounding area, encompassing a wide variety of food firms. Information from this study will be useful not only as a guide for long-range planning by the Authority but also in determining the impact of the development of a modern wholesale food distribution center on the total food marketing system of the area.

Market Plans for Hartford, CT

Expansion and modernization of existing markets may offer a less expensive alternative to construction of new facilities. A recent report, "Expansion Planning for the Connecticut Regional Market in Hartford," published jointly by AMS and the State of Connecticut Regional Market Authority, outlines alternatives for revitalizing this market, which was constructed in the 1950's. Using existing and new buildings with modern handling and storage techniques, a revitalized Hartford market could double the capacity of existing facilities and provide work for almost 500 local residents in an area of high unemployment.

Southern New Jersey Wholesale Food Center Development	The recently released Marketing Research Report (MRR) 1144, "Improved Food Distribution Facilities for Southern New Jersey," completes the formal research phase of this study and outlines plans for a new regional wholesale food distribution center. This new center would require a 150-acre site and cost about \$19 million to construct.
Catfish Study for Oklahoma	AMS, in cooperation with Langston University and Red Ark Development Authority, Lane, OK, is developing models to analyze costs and returns related to various production and marketing systems for catfish in Oklahoma. Models will be used to predict (1) production capabilities for growers with costs for various-size operations, both with cage culture and open pond systems; (2) price structure and demand using various marketing systems; and (3) costs for various-size catfish processing plants and the impact of economies of scale.
Modular/Metric Shipping Containers for Produce	To realize the benefits of increased storage, transport, and handling efficiencies, research is being conducted to reduce the variations in container sizes used for fresh produce. Modular replacements have been recommended for produce containers that represent about 75 percent of the volume shipped, and research is being conducted to measure industry adoption of modular/metric replacements.
Uniform Coding of Produce Items	In conjunction with the United Fresh Fruit and Vegetable Association and the Produce Marketing Association, work is continuing on standardizing price codes for use at checkout stations of supermarkets on over 800 produce items.
Alternative Marketing Opportunities	Studies are conducted in cooperation with the universities and State departments of agriculture to help farmers identify market opportunities applicable to their area and available resources. One such study in southern Virginia led to a cooperative being formed to produce, pack, and market broccoli and cantaloups. A study has been completed for a similar group in southeastern Oklahoma and another study has been undertaken with a six-county group in north-central Virginia. MRR 1146, "Determining Commercial Marketing and Production Opportunities for Small Farm Vegetable Growers," presents guidelines that might be used by other groups.
Vegetable Marketing	Market development research is being conducted in cooperation with the Horticultural Producers Federation to help the small farmer cooperatives in six Southeastern States enter and compete in the wholesale vegetable market. The research is directed toward assisting the co-ops in improving efficiency through implementing marketing and management tools, standardizing packages and materials, and quality control programs. The Federation is striving to develop a centralized marketing program that will better serve the consumer needs while helping small and limited resource farmers increase their income.

Computer Feasibility for Independent Fresh Fruit and Vegetable Wholesalers	This research defines the information requirements of fresh fruit and vegetable wholesalers, determines alternative systems to satisfy these requirements, and develops cost estimates for the selected alternatives. The research results were published in MRR 1142, "Computer Feasibility for Fresh Fruit and Vegetable Wholesalers." The recommended computer system has been developed in the private sector and is being implemented at various wholesale fruit and vegetable companies in the United States and Canada.
Potential for Modularization of Frozen Food Containers	Research has been completed to improve efficiency in frozen food handling. There are 604 case sizes used to ship over 950 frozen food items; very few of these sizes are modular to a standard shipping platform. By substituting 49 modular sizes for the 604 case sizes presently used, the distribution costs would be reduced. The study results were published in MRR 1147, "Modularization in the Frozen Food Industry."

OFFICE OF TRANSPORTATION

The Office of Transportation (OT) helps assure that there is an efficient and equitable transportation system serving the needs of agriculture and rural areas. This is accomplished through research on specific transportation problems, analysis of agricultural impacts of policy changes and proposed changes, and informational assistance to shippers of agricultural commodities and carriers.

Represented
Agriculture
at ICC

The Office of Transportation submitted filings to the Interstate Commerce Commission to (1) retain certain motor carrier reporting requirements, (2) advise the ICC on the impact of the motor carrier insurance crisis, (3) obtain rate decreases when carrier costs decline, (4) obtain the proper degree of disclosure of shipper-carrier contracts, and (5) maintain regulation of demurrage rules to prevent discrimination.

Transportation
Conferences
Held

OT sponsored conferences in Fresno, CA, and St. Louis, MO, designed to provide shippers, receivers, exporters, and State agricultural and transportation officials with a better understanding of USDA's role in transportation matters. Presentations included past legislative impact on agricultural and rural areas and transportation considerations in exporting agricultural commodities.

Drought
Assistance
Provided

During the severe drought in the spring and summer of 1986, OT maintained a drought assistance hotline and coordinated the communications between major rail and motor carriers and State departments of agriculture. Over 100,000 tons of donated hay were transported free of charge to drought-stricken farmers. The cost savings to the farmers are estimated to be \$7-\$10 million.

"Access Rural
America"
Launched

As a part of the new initiative "Access Rural America," OT completed a multi-State study of rural road and bridge finance options for local government officials and published "Financing Rural Roads and Bridges in the Midwest." OT also assisted shippers and a local economic development agency in Itawamba County, MS, to retain rail service by purchasing and operating a 24-mile rail that was scheduled for abandonment.

U.S.-Mexico Trade Relations Improved	Working directly with officials of the Mexican National Railway and U.S. railroads, the OT border coordinator has developed a cooperative working relationship and facilitated trade. A reduction in time for the return of empty rail cars from Mexico to a nominal 15-day turn-around time has saved thousands of car-days and reduced costs for both sides. The reduction of time for Mexican quality inspectors to inspect cars of U.S. grain awaiting Mexican clearance has permitted more cars to be cleared for crossing. OT also helped arrange the transportation of over 12,000 truckloads of Mexican sorghum from Tamaulipas, where there is inadequate storage, to the Public Elevator at Brownsville, TX, for reshipment to ports in Mexico.
Caribbean Basin Initiative Supported	OT participated in an agribusiness-sponsored workshop in Miami, FL, on proper methods of packaging, handling, and transporting perishables, as well as a U.S. Department of Transportation Caribbean Basin Initiative working group geared to undertake action on issues that block CBI objectives. OT officials also drafted a handbook on transport and handling requirements for tropical and exotic fruits and vegetables, which is designed to promote trade in tropical agricultural products during the winter and which, in turn, should stimulate sales of U.S. farm and processing equipment, fertilizers, and packaging materials.
Central American Ports Studied	OT conducted port grain handling studies in three Central American countries. At Puerto Cortés, Honduras, it found local millers could save approximately \$1 million a year and USDA \$200,000 a year in ocean freight differential payments if storage facilities were constructed.
EEC Trade Relations Enhanced	OT implemented the treaty regulations of the United Nations Economic Commission for Europe Agreement of the International Carriage of Perishable Foodstuffs. These regulations will allow U.S. exporters to market refrigerated food products more readily in European Economic Community (EEC) nations. OT also implemented a program to certify American manufactured refrigerated trailers and containers for sale or lease in the EEC and thus enhanced U.S. competitiveness in this foreign market.
Dairy Termination Program Promoted	OT provided information and developed an educational program that includes seminars on livestock shipping and "Transportation Fact Sheets" for shippers to resolve transportation problems arising from the Dairy Termination Program, which generated an export market for more than 90,000 head of cattle.

OFFICE OF INTERNATIONAL COOPERATION AND DEVELOPMENT

The mission of the Office of International Cooperation and Development (OICD) is to coordinate and conduct the Department's international programs in agriculture and related fields.

International research and education programs include scientific and technical exchanges, administration of collaborative research, representation of USDA and U.S. Government research and educational interests in international organizations, and training and facilitating private sector involvement in agricultural development and cooperation. Programs are conducted cooperatively with other USDA and U.S. Government agencies, universities, and the private sector.

Honey Bee
Varroa Mite:
Brazil

A recently completed collaborative research project enabled Cornell University scientists to study on site in Brazil a serious parasite of honey bees. The varroa mite, accidentally spread by man from Asia to most of the major beekeeping areas of the world (except North America and Australia), remains a threat to the U.S. beekeeping industry. This project provided knowledge of the varroa mite's reproductive and feeding behavior, development, and method of spread. The information was needed to identify stages and time of year for control procedures and to refine nonchemical methods.

Potato Late
Blight Disease:
Mexico

The spraying of fungicide to control late blight in potatoes is an expensive and time-consuming requirement on all acreage in the more humid areas of the United States. Collaborative research conducted by Cornell University in Mexico on the control of late blight enabled scientists to identify methods to suppress drug-resistant pathogens.

Insect Pests
"Migration":
Mexico

U.S. and Mexican researchers have tracked the international movement of several nocturnal insects that are important to the farm economies of the South and the Great Plains. They include the corn earworm, the fall armyworm, and the cotton budworm. The researchers found that nocturnal adult insect populations fly to heights of several hundred meters at dusk or dawn. By studying the movement and population dynamics of such economically important pests, scientists are better able to develop prediction models that allow farmers to pinpoint the timing and scope of insecticide applications.

Nonchemical
Control of
Soilborne Plant
Diseases:
Israel

Scientists at the University of California at Davis and the Hebrew University, Israel, are exploring solar heating of soils (solarization) as a new method for controlling soilborne diseases. Transparent polyethylene sheeting is used to cover the soil and thereby increases soil temperatures and kills plant pests. As a consequence of this work, commercial use of solarization has already started in the United States, Israel, and other countries. This trend is expected to continue as a low-cost and environmentally sound method of controlling soilborne diseases.

Citrus Research:
Spain

OICD coordinated a joint U.S.-Spain workshop on the international exchange of citrus germplasm held at the University of California at Riverside, April 15-17, 1987. The workshop, which was funded under an award from the U.S.-Spain Joint Committee for Scientific and Technological Cooperation, brought together experts from Moncada, Spain, ARS at Orlando, FL, the University of Florida, and the University of California at Riverside to discuss sources of citrus germplasm, pathogen detection procedures, preservation and shipment of germplasm, and regulatory considerations and safeguards.

Karnal Bunt
Wheat Disease:
Mexico

A recently completed collaborative research project with ARS and university scientists in Utah, in collaboration with scientists at the International Maize and Wheat Improvement Centre in Mexico, resulted in new information on potential control and spread of the serious soilborne disease Karnal bunt. This disease reduces wheat yields and could severely restrict our exports.

Biological
Control of Water
Hyacinth:
Egypt

Water hyacinth is ranked worldwide as among the 10 most economically important weeds and as the single most important aquatic weed pest. This entomological research project conducted in Egypt identified the pathogens and predators of water hyacinth. Since the introduction of these enemies of water hyacinth into the United States, the infested area in Florida has dropped from over 100,000 acres to less than 20,000 acres and in Louisiana from 1.7 million acres to about 200,000 acres.

New Apple
Rootstocks
Developed: Poland

There has been a continuing need for new rootstock with extreme dwarfing and low-risk, high producing characteristics. A number of new rootstocks of apples were developed in Poland during several years of research sponsored by the Special Foreign Currency (SFC) Program. In addition, rootstocks developed in the Soviet Union and the People's Republic of China were obtained through Polish researchers. These rootstocks, none of which would be available to U.S. apple growers without the SFC program, can now be purchased commercially in the United States.

Sugar Beet
Research:
Poland

Nearly 1.5 million acres of U.S. cropland are planted annually to sugar beets for domestic sugar processing. Research conducted in Poland has provided the United States with 85 accessions with increased resistance to diseases and nematodes and increased water-stress tolerance. The importance of the new germplasm to U.S. breeders is demonstrated by the fact that this valuable genetic material introduced in 1985 has already been distributed throughout the United States to researchers and will soon be available as commercial varieties for U.S. farmers. It is of special importance to growers in Michigan, Ohio, Minnesota, North Dakota, Texas, and Nebraska, where over half of total U.S. production occurs.

China:
Forestry
Cooperation

The U.S.-People's Republic of China Joint Working Group for Agricultural Cooperation in Science and Technology, meeting in Beijing, China, in April 1986, formally marked resumption of scientific and technical exchange activities between the two countries.

Through these exchanges, the Forest Service was able to resume cooperation in gypsy moth control. Chinese scientists visited the United States to study natural enemies of the gypsy moth. U.S. scientists will visit China to collect natural enemies for rearing in the United States to establish an integrated pest management program for controlling the gypsy moth problem in U.S. forests.

A cooperative program in forest pathology was planned for future exchanges on disease control methodology and collection of genetic materials for use in breeding disease-resistant tree species. The 1986 program also included activities in animal health, grasshopper management, agricultural information and reporting systems, and soil and water conservation.

Soviet Union:
Exchange Teams
Yield U.S.
Benefits

The U.S.-U.S.S.R. Agreement on Cooperation in Agriculture was reactivated in Moscow in June 1985. Benefits were achieved in several areas. The animal and plant protection and quarantine teams were able to pinpoint problems of Soviet clearance of imported U.S. agricultural commodities. Information gained by the Forest Service on seedling physiology strengthens the U.S. research program and may improve U.S. reforestation efforts. Other activities focused on biological control of the gypsy moth through examination of Soviet research on similar pests. U.S. team visits have stimulated the continued exchange of germplasm for cereals, forage, fruit, and oilseed crops, for which the Soviet Union is a prime source. Germplasm received for cold-hardy tree varieties is used in U.S. research to control erosion and protect crops in the Plains States.

Republic of
Ireland
Initiating
Agricultural
Cooperation

The Administrators of the Office of International Cooperation and Development and the Cooperative State Research Service are jointly responsible for implementing Section 1420 of the Food Security Act of 1985 on cooperation in agricultural science and technology with the Republic of Ireland. A USDA delegation visited Ireland in November 1986 to define topics for exchange visits and to discuss other programs that would benefit both countries. Potential topics for cooperation include agricultural extension, food processing, animal health, and quarantine.

Africanized
Honey Bee

A special session of the Tri-Country Committee of the American Beekeeping Federation was funded by OICD. Experts from the United States, Mexico, and Canada discussed the northward movement of Africanized honey bees and long-term solutions to problems of eradication and quarantine. Two U.S. bee experts traveled to Kenya with OICD funding to collect bees and discuss measures to combat the problem with Kenya officials. A selective breeding program for more docile bees will begin soon in Kenya. OICD co-sponsored an international conference at Ohio State University involving international acarologists and bee biologists in basic and applied research related to Africanized honey bees and mites parasitizing honey bees.

Caribbean Basin
Initiative (CBI)

USDA's CBI Agribusiness Development Workshop in Puerto Rico last September attracted 650 private sector entrepreneurs from 23 Caribbean countries, as well as the United States, Mexico, Venezuela, Ecuador, Finland, and France. In-country workshops were conducted on marketing in Peru and agribusiness development in Ecuador. Agribusiness Promotion Council members investigated the potential for investment by the private sector at the first annual International Fair of Agriculture, Cattle, Fish, and Feed in Panama for Caribbean and Latin American countries.

Agribusiness
Information
Center

The Agribusiness Information Center provided information on marketing, import regulations, phytosanitary requirements, and investment opportunities to U.S. and Caribbean entrepreneurs and others during its first year of operations. A quarterly newsletter focuses on specific issues of interest to domestic and international agribusiness.

Cochran
Agricultural
Scholarship
Program for
Middle-Income
Countries

Since 1984, over 300 senior and midlevel managers, scientists, and technicians from middle-income countries, including Algeria, Colombia, Iraq, Ivory Coast, Korea, Malaysia, Mexico, Turkey, Venezuela, and Yugoslavia, have received training in such areas as grain storage and handling, marketing, plant quarantine, poultry production, and agricultural extension. This training is part of the Cochran Agricultural Scholarship Program. Gaining technical knowledge and experience, trainees also learn firsthand about U.S. agriculture and the free market approach to international trade.

FOREST SERVICE

The Forest Service (FS) research program is responsible for developing scientific and technical knowledge to enhance the economic and environmental values of America's 1.6 billion acres of forest and associated rangelands. Research is generally long range and high risk, covering a wide spectrum of biological, economic, engineering, and social disciplines.

Research is conducted through eight regional forest and range experiment stations and the Forest Products Laboratory at Madison, WI. More than 2,800 studies are in progress. Approximately 800 scientists are stationed at 76 locations throughout the States, Puerto Rico, and the Pacific Trust Islands.

Atmospheric Deposition Research

Current research is focused on (1) assessing the effects of atmospheric deposition on terrestrial and aquatic ecosystems and (2) determining its chemical characteristics. The present chemical climate of wild lands is being evaluated to find out if and how land and water resources are changing in response to acid rain. The atmospheric deposition research effort is a major component of the interagency National Acid Precipitation Assessment Program.

FS 1986 research determined that--

- o Sulfate deposition is increasing in the Southeastern United States, and some watersheds are reaching the point where they can no longer buffer its acidifying effects.
- o In New England, soil organic matter has a key role in reducing the effects of acidic rain on leaching of soil nutrients.
- o Acidic rainstorms and rapid melting of acidic snow temporarily increase the acidity of lakes and streams.

Research To Foster International Trade in Timber and Wood Products

Although the United States exports about 15 percent of the timber products it produces, it is also the world's largest importer of forest products. With our vast forest resource base, we could transform our Nation into a net exporter of forest products and thus increase domestic employment and also help improve our overall foreign trade balance. Forest Service economics research helps policy makers formulate

strategies to increase wood export opportunities. It provides analyses of current trade flows, identification of factors influencing trade flows, improved methodologies for trade analyses, and information on present and prospective impacts of international trade on the U.S. timber supply and demand situation.

Results of research in 1986 include--

- o The Caribbean area is a major market for U.S. forest products, especially southern pine structural lumber, with exports to that area totaling \$157 million in 1983.
- o Recent changes in the exchange values between the U.S. dollar and the Japanese yen will affect forest-products trade prospects with Japan, perhaps less favorably than anticipated since the exchange-rate shifts may precipitate a slowdown in the Japanese economy and market demand.
- o Currency exchange rates between the United States and Canada do favor the increased importation of Canadian forest products, but other cost factors are even more significant.

Biotechnology and
Forests of
Tomorrow

Biotechnology, including genetic engineering, will help us advance timber growth and pest controls much more quickly than conventional research methods. For example, biotechnology is expected to lead to new lines of disease-resistant trees, nonchemical controls for insect pests, and major reductions in the negative environmental impact of wood processing.

FS biotechnology research has already found that--

- o It is possible to isolate plant cells and inoculate them with disease-causing fungi to determine the relative resistance of different genetic lines to the disease.
- o It is feasible to isolate a herbicide-tolerant gene from the common Salmonella bacterium and transfer the tolerance genetically into a hybrid poplar. This gene transfer could lead to more cost-effective control of unwanted forest vegetation.
- o Using a virus, a microbial (nonchemical) insecticide for suppressing the Douglas-fir tussock moth has been developed and registered with the Environmental Protection Agency.

- o Based on the fungi that cause white-rot decay in wood, FS scientists have discovered and isolated an enzyme that breaks down wood cell-wall constituents without toxic chemicals. This development in bioprocessing will reduce energy consumption in wood processing and lessen the use of chlorine for bleaching wood pulp. This discovery suggests that wood-processing chemistry can be made less dangerous to the environment.

Critical Wildlife-Timber Management Interactions

Complying with the Endangered Species Act and the National Forest Management Act can lead to serious conflicts between protecting wildlife and fish and producing a consistent flow of forest products from the resource base. Among the highest priority research projects is a study of those species with the greatest potential of being impacted by planned forest-management activities. This includes, but is not limited to, study of wildlife associated with old-growth forest habitats, interactions between timber management and fish, and threatened and endangered species.

Here are some examples of FS research:

- o The red-cockaded woodpecker research formed the basis for the new recovery plan for this species. By more precisely defining its habitat requirements, the Agency can now harvest up to 20 percent more timber from Florida's national forests.
- o Some wildlife species depend on or reach their highest populations in forests that are older than the ideal age for economic harvest for wood products. Presently FS is examining how to manage some of the 85 species of North American birds and 49 species of mammals that use tree cavities characteristic of older forest stands and at the same time maintain an efficient timber-management program.
- o Since the northern spotted owl could be irreparably harmed by indiscriminate and large-scale cutting of old-growth stands, research is focusing on this species' habitat use, movements, breeding activity and success, juvenile dispersal, prey ecology, and potential competition with barred owls. Research will be used to minimize the economic impact of providing for the spotted owl habitat.

Southern Forest Productivity

In the 60's, research projections suggested that higher demands for wood products would be met primarily from increased timber harvest in the South. The southern timber resource was expected to produce enough wood to meet half of the Nation's needs by the year 2000. Employment and income in the forest industries in the South already exceeded those of other major manufacturing industries. However, by the late 1970's, concern developed about the capability of the southern softwood timber resource to support continued expansion of the forest industries. Multiple-use and environmental conflicts so prevalent on predominantly Federal land in the West were also increasing in the South.

Here are some highlights of recent research on the southern timber resource.

- o Net annual timber growth has leveled off or begun to decline.
- o Mortality from insects and diseases is increasing significantly.
- o Timber removals have been rising rapidly because of increased harvests. For softwoods, removals are above net annual growth over large areas of the South.
- o The South is facing a future of rising raw material prices, much lower rates of growth in timber harvests, and declining employment in the forest industries.
- o There are many opportunities to increase forest productivity in the South, but expanded programs of protection, education, financial assistance, research, and management are essential because timber supply usually does not increase in proportion to price.

Special Projects, Competitive Grants

The objective of the competitive grants program is to develop fundamental knowledge and understanding of wood properties and structures, biological mechanisms of forest organisms, and relationships within forest ecosystems. The congressionally provided budget of \$6,505,960 in FY 1986 was directed at basic research in (1) improved harvesting, processing, and utilization of timber resources, with emphasis on chemical, mechanical, and engineering properties of wood and wood materials and (2) fundamentals of forest biology, including biotechnology.

In 1986, 63 proposals were approved; the average grant was approximately \$98,000 and covered a 3-year period. Grants were awarded in basic harvesting technology, wood chemistry and biochemistry, physical-mechanical properties of wood and basic processing technology, structural wood engineering, genetic structure and function including biotechnology and genetics, and mechanisms of interactions in forest ecosystems.

Fire and Atmospheric Sciences Research

The new FS computer-generated wind models enable the Agency to predict the spread of the gypsy moth from newly discovered infestations. The models couple what we know about wind conditions and moth dispersal and then output the probable concentrations of moth larvae on a map of the outbreak area.

In 1986, FS researchers discovered what combinations of timber harvesting practices and weather produce the least smoke for a given prescribed burning objective. They also developed a soil-heating model that can predict the magnitude of subsurface temperatures during wild or prescribed fires.

Forest Insect and Disease Research

Twenty years of research on mountain pine beetle epidemics has led to the development of (1) methods to identify stands susceptible to beetle attack, (2) techniques to predict lodgepole pine losses caused by the beetle, and (3) silvicultural prescriptions to help prevent or reduce these losses.

A cooperative team of researchers from the Forest Products Laboratory and the U.S. Navy has found a new method for eradicating decay fungi deep within structural timbers. The method will extend the service life of structures and avoid expensive repairs or replacement at inflationary costs.

Forest Inventory and Analysis

Forest inventory publications were issued this year for California, Louisiana, Montana, New Hampshire, Vermont, Virginia, and Wisconsin. Also published were timber-production reports on veneer log use, characteristics of private land owners of timber, and improved technologies for making the timber-inventory process more efficient.

"Operability" is the relative ease or difficulty of managing or harvesting timber because of physical conditions in the stand or on the site. The Agency has developed a way to evaluate operability using information already collected during statewide forest inventories. This method will help users make harvesting decisions.

Renewable Resources Economics Research	A new publication, "Toward an Improved Framework for Estimating RPA Values," identifies important issues and provides new concepts for assigning economic values to both tangible and intangible forest products. Results documented in this handbook will help in developing the 1989 Resources Planning Act.
	How changes in the South's forest-products industry in the 1970's affected employment, earnings, and productivity is the subject of a series of analyses by the Forest Service and cooperating university economists. The industry has grown substantially since the mid-1970's. Also, five Southern States can boast forest-products industries whose average productivity exceeded the industry average for the Nation.
Trees and Timber Management Research	Scientists have developed guidelines to help managers convert old-growth or mixed-growth stands into managed stands. These guidelines pertain to stand succession, windfall risk, and insect and disease susceptibility. They also recommend cutting practices that help integrate timber production with increased water yield, improved wildlife habitat, enhanced opportunities for recreation, and scenic values.
	Researchers have found that production of seed for reforestation can be greatly increased by locating pine seed orchards in warmer climates. And by varying the timing and spatial patterns of seedlings from different genetic groups within a species, managers can achieve almost any pattern of genetic diversity in either pure or mixed stands.
Watershed Management and Rehabilitation Research	Low-cost, low-maintenance forest roads can be consistent with protection of water resources. In Idaho, FS researchers found that road design has less effect on erosion than the stage of construction when a storm occurs. In West Virginia, they found that using at least 3 inches of gravel decreases soil losses. In North Carolina, they achieved better control of sediment deposition by using narrower filter strips to trap sediments along roadsides.
	To leave more water for streamflow and protect Arizona soils from erosion, the Agency investigated converting chaparral shrubland to grassland. Changing to grass can increase streamflow by 72 percent without significant danger of flooding surrounding areas.

To reclaim surface mine spoils, FS found that forest topsoil, which is full of seeds, is superior to either a commonly recommended ground-cover mix or to a combination of forest soil and the mix. The natural seed-bank community from the forest topsoil produced greater plant biomass and retained more fertilizer-related minerals, too.

Wildlife, Range, and Fish Habitat Research

Researching wildlife in the managed forest has revealed that (1) the response of ovenbird and wood thrush to forest-management activities can be predicted; (2) bird census counts do not vary during the first 5 hours of the morning, so census timing can be adjusted to accommodate workers' schedules; and (3) to maintain squirrel populations near clearcuts, foresters need to leave uncut streamside strips at least 100 feet wide.

In examining how natural obstructions in stream channels affect the survival of fish species such as coho and chinook salmon and steelhead trout, large obstructions were found to stabilize the channel and create pools where larger fish reside during the summer. This research also provided optimal designs for artificial obstructions so fisheries managers can modify the natural habitat to favor particular species.

Forest Recreation Research

Working with Southern Illinois University, FS planned a survey to identify which attributes of bicycle trails are important to riders in greater Chicago's forest preserves. Next, it developed a model to predict user satisfaction with a trail, given characteristics such as its surface, length, distance from the cyclist's home, and terrain. Trail surface and distance from home were found to be particularly important to bicyclists.

Residential trees can be planted so that resulting sunlight and shade control greatly reduce home energy costs. Two new computer programs--SOLPLOT and SPS--graphically illustrate shade location and show energy saved by planting trees in various places.

Forest Products and Harvesting Research

Cull trees, forest residues after harvesting, and mill wastes can be turned into valuable products like flakeboard, particleboard, and oriented strandboard. New publications documenting techniques for producing composite panels from low-value trees and residues have reported new technology to user groups at mills in New England, the East, the South, and the Rocky Mountains.

International Forestry

SOFORM, a chemical treatment that imparts wet-stiffness to paper and paperboard, can make paper almost as stiff wet as dry. SOFORM will enable builders to construct emergency shelters for disaster victims and wall and ceiling panels from paperboard products, which were not feasible in the past because of paper's inherent susceptibility to water damage.

The International Forestry Program provides leadership, coordination, and direction for Forest Service involvement in forestry worldwide. Examples of 1986 accomplishments follow.

- o FS provided leadership and staff support for 12 cooperative research projects in 6 countries, addressing new technologies in wood utilization, tree genetics, forest protection, and regeneration practices.
- o The Agency undertook 20 science and technology exchanges with 11 countries, including 2 new programs with the Soviet Union and the People's Republic of China. Particular benefits include acquisition of new tree germplasm, data on atmospheric deposition, and information on biological control of the gypsy moth.
- o It provided practical training programs at Forest Service units across the country for more than 260 international visitors in forestry and related fields. A new International Volunteer Program was established to help support selected international visitors.

Cooperation between the Forest Service and the U.S. Agency for International Development (AID) continued to develop and to benefit AID, FS, and tropical countries. The Forestry Support Program serves as a direct technical backstop to AID and the Peace Corps worldwide and helps design, execute, and evaluate a wide range of AID-sponsored forestry activities abroad. Examples in 1986 include--

- o Evaluation of a reforestation project in Sudan and agroforestry activities in Haiti and Ecuador.
- o Analysis of damage and development-of-action plan to combat an insect attack on leucaena in Asia-Pacific countries.

- o Preparation of a Spanish-language training manual on agroforestry, in cooperation with the Organization of Tropical Studies and the Center for Research and Training on Tropical Agriculture.

FEDERAL GRAIN INSPECTION SERVICE

The Federal Grain Inspection Service (FGIS), in the process of fulfilling its mandate to administer the Nation's grain inspection and weighing system, conducts applied research. FGIS is an action-oriented agency with responsibilities for developing new or improved methods and equipment for grading, inspection, and weighing of grain; inspection standards; inspection and weighing procedures; and other grain-marketing services and programs. FGIS needs supportive research to solve problems and improve the efficiency of its inspection and weighing activities. FGIS and ARS have executed a Memorandum of Agreement that establishes policies, responsibilities, and procedures concerning research in grain marketing. The Director, Standardization Division, shares with the Administrator ultimate responsibility for overall planning, research, standards development, and related support programs and activities assigned to FGIS.

Research involving FGIS is carried out (1) in-house and (2) by reimbursable agreement with ARS or by contract with any acceptable vendor through the contracting capability of APHIS. Projects for which the personnel and equipment are available or reasonably obtained are handled in-house.

Grain-Moisture Measurement

The investigation of alternative moisture determination procedures for grain continues. The in-house research on the Karl-Fischer Titration procedure has been advanced. The development of a single-kernel moisture apparatus for use with corn is progressing through cooperative agreement with ARS.

Free Fatty Acid in Soybean Oil

The soybean line was changed last fall to reduce the level of free fatty acid (FFA) in the extracted oil. Researchers are monitoring a percentage of export soybean cargoes to determine the effectiveness of these changes on reducing the FFA level in the oil.

A cooperative agreement between FGIS and ARS is nearing completion to determine factors that affect oil quality and to develop procedures for rapidly measuring these factors.

Wheat Hardness	Wheat hardness investigations continue in a priority status. Evaluation of the single-kernel Norris Hardness Tester is being carried out at the Kansas City Technical Center. A bulk near-infrared procedure for hardness determination has been published by the American Association of Cereal Chemists. FGIS collaborated in producing the data used to establish this procedure. Two additional single-kernel hardness testers employing different operating principles are being developed by outside researchers and will be evaluated by FGIS as soon as they are available. Additional classification research will also be funded by FGIS through cooperative agreements with ARS.
Breakage Susceptibility of Corn	A contract with Kansas State University was let by FGIS to establish the credibility of the Wisconsin Breakage Tester as a tool for predicting the susceptibility of a lot of corn to breakage in normal handling and transit.
Toxic Seeds	ARS at Albany, CA, is continuing a long-term investigation into the toxicity of five common weed contaminates of food and feed grains.
Grinding Study	A study to determine the effects of using variable grinding procedures on data produced by subsequent near-infrared evaluation is underway.
Oil and Protein by Near-Infrared Reflections (NIR)	The development of procedures using NIR to determine oil and protein in soybeans and oil in rice is continuing.
Acceptance and Maintenance Tolerance	A project to set up acceptance and maintenance tolerances for all testing equipment used by FGIS has begun. These procedures and tolerances will determine what specification an instrument must meet in order to be eligible for use in the inspection system and what tolerances it must maintain in order to operate within the grain inspection system.

EXTENSION SERVICE

The Cooperative Extension Service, a three-way partnership, includes the USDA Extension Service (ES), the Cooperative Extension Services in each State and territory at the land-grant universities, and the local Extension office in almost all the Nation's 3,150 counties. In addition to support from Federal, State, and local governments, the Extension system calls on the private sector as an active partner with a record 2.9 million volunteers contributing to Extension programs. This unique structure helps Extension educators quickly address national and local problems by integrating knowledge and new technology into educational programs that people can use immediately. One in every four American families turns to Extension for educational programs that focus on the following subjects.

Competitiveness and Profitability in American Agriculture

Producers need to access and apply research-based, cost-effective technologies to enhance the future competitiveness and profitability of American agriculture. The American economy relies heavily on a strong competitive food and fiber production system.

Extension showed farmers how to reduce operating costs, how to reduce farm energy consumption in crop production, how to improve crop and animal production, and it provided assistance in financial planning to more than 100,000 families. Extension assistance included (1) computer programs to help farmers prepare financial statements and business plans of action and (2) intensive workshops to show farmers how to carry profitability beyond 1986 to the year 2000.

In Texas, through Extension's brucellosis control program, increased calfhood vaccinations reduced economic losses by an estimated \$6.9 million. Nationally since 1984, the number of quarantined brucellosis herds dropped 37 percent.

Extension's Integrated Pest Management (IPM) Program reduces costs associated with pest management, risk of crop loss, chemical use, and impact on environment and health. In one study of 3,500 growers (15 States and 9 commodities), IPM users experienced a total difference in net returns over nonusers in excess of \$54 million per year.

The Integrated Resource Management (IRM) Program is credited with adding in excess of \$3 million per year to beef producer income in Idaho and Missouri. Three States credit Extension's IRM Program with adding \$8 million to hog income; two States report an increase of almost \$500,000 to sheep income.

Extension programs in Colorado included recommendations for yearling range cattle to produce an additional gain per animal of 20 to 30 pounds; workshops in Mississippi included a light calf winter grazing system that can reduce the break-even price for weaned calves by \$16.

Family and Economic Well-Being

The well-being of the family, the most fundamental institution in society, is essential to national strength, continuity, and stability. Daily, American families must make decisions involving time, skills, money, and family relationships in an increasingly difficult, stressed environment.

In 25 States and 3 territories, Extension reached over 1 million individuals with programs to strengthen their families and establish relationships that promote communication and build self-esteem. Indiana trained 3,000 volunteers to teach 47,000 parents about practices that improve communication, problem solving, and decision making.

In 21 States where the farm crisis is most severe, Extension established telephone hotlines; opened counseling centers; formed family support groups; produced video, slide, and radio materials on stress management; developed a home-study course to help families recognize and treat depression; and worked with youth to help them cope with increased family tension.

Extension's financial management programs extend beyond farm families. In 1986, nearly 1 million consumers reduced their food bills by an average of \$30 monthly; 81,000 consumers saved \$1.6 million in energy bills; and 2 million families increased their discretionary income with improved budgeting, long-term financial planning, credit management, and marketable skills.

The Extension program, "The Rural Crisis Comes to School," helped 3,000 teachers in Iowa recognize and understand stress symptoms in students and included ideas for school activities to address the problems. "On My Own and OK" teaches latchkey children 8-13 years of age practices that promote safety and well-being.

Improving Nutrition, Diet, and Health

All members of the food system, from producer to consumer, make decisions affecting the nature of the food supply. The relationship between the economic success of the food industry and the nutritional quality and safety of food is increasingly intertwined. In 1986, Extension reached 10 million people with programs to help them maintain their health and well-being within the confines of family living, lifestyles, and budgets.

Over 900,000 low-income adults and youth improved their diets and reduced food bills through the Expanded Food Nutrition Education Program. Extension-trained volunteers and paraprofessionals contributed significantly toward program delivery.

Food procurement programs in 4 States saved 12,542 participants an average of \$16 monthly for an annual savings of almost \$4 million. Extension's Urban Gardening Program resulted in 180,000 city dwellers harvesting \$20 million worth of fresh vegetables and fruit, which they had planted in vacant lots, alleys, and apartment balconies. For many, the food produced made the difference between going hungry and being fed.

Nationwide, farmers reduced chemical residues in meat and poultry products by 82 percent and altered other farming practices to meet consumer demands. In 1986, more than 200,000 farmers and commercial operators were trained to apply and dispose of pesticides safely.

Building Human Capital

Our Nation's economic productivity, international competitiveness, quality of life, and democratic form of government ultimately rest on the capabilities of our youth and adults. Extension aggressively develops the leadership potential of adults and youth, and in 1986 provided intensive training for--

- o 500,000 elected officials and community leaders who helped their communities improve services, attract new businesses, and conserve natural resources.
- o 700 young farmers, business leaders, and rural residents who participated in 1- and 2-year study programs to increase their ability to respond to complex problems.
- o 2.9 million volunteers who developed the ability to organize, communicate, and contribute to their communities in agriculture, nutrition, conservation, and financial management.

Approximately 4.5 million young people from farms, cities, and suburbs are participating in 4-H clubs, camps, and school programs. Through this Extension program, they build practical skills and become self-directed, productive members of society.

Forty-eight States participated in a Family Community Leadership Dissemination Program. Twenty-eight States utilized Extension's Master Volunteer Teacher Program, in which 25 hours of training are received by participants who agree to pay back 40 to 50 hours of teaching.

A Family Community Leadership Program in 6 Western States and a 6-State New England Rural Leaders Program provided intensive training to 1,300 community leaders to help them become more effective public decision makers.

Conserving and Managing Natural Resources

The Nation's health and well-being are dependent on the conservation and management of its renewable natural resources--soil, rangeland, water, forests, and wildlife. Extension programs help people conserve and manage responsibly these natural resources.

In Texas, Extension helped to develop the Low Energy Precision Applicator (LEPA), an irrigation system that saves water by approximately 20 percent and reduces energy to run the system. LEPA puts the water in pumps directly on the crop and will pay for itself in one growing season or less.

A focused nine-county Extension Forest Land Management Program in Georgia resulted in landowners adopting improved management practices that increased the area's stumpage value by \$289,000; given that \$2 of timber sales generates \$16 through transport, processing, and marketing, the total value of this program is approximately \$4.6 million.

Extension programs in Louisiana, Tennessee, New Mexico, Michigan, and Colorado helped landowners increase income from fish and wildlife by an estimated \$24 million. A 19-county pilot project in Texas helped ranchers increase income from hunting and fishing leases by \$7 million. Nationally, landowners credit Extension programs with reducing crop, livestock, and property damage by \$45 million annually.

Revitalizing Rural America

The survival of rural America is dependent on the expansion of income and employment opportunities in rural America. Extension educational programs address development of new economic opportunities, supplemental income through off-farm jobs and home-based businesses, improved management capabilities for local leaders, and strengthened capacity of local governments to finance and operate facilities and services.

In 1 north-central State, Extension taught 16,000 rural business leaders better management skills that increased sales a total of \$13.1 million, which led to 3,000 new jobs, the creation of 1,500 new businesses, and the expansion of 1,300 small businesses. The State tax base increased by \$4.5 million.

Extension programs in Mississippi, Georgia, and Oklahoma helped local governments improve public facilities, including transportation, medical facilities, and solid waste handling.

Eighteen States conducted economic and business development programs to increase family income, provide management skills, and assist in the establishment of home-based businesses. Additional income of over \$8 million was generated by 987 new businesses, including catering, bed-and-breakfast, child care, and so forth. In Missouri, a lady used Extension-taught sewing and management skills to maintain her family after it became a victim of the farm crisis; she now employs 50 seamstresses and had a 1986 sales target of \$3.5 million.

NATIONAL AGRICULTURAL LIBRARY

The National Agricultural Library (NAL), with a collection of 1.9 million volumes, is the largest agricultural library in the free world. It collects technical information on agriculture and related subjects from all over the world and makes it available with the use of computer databases to scientists, educators, and farmers. The library is the coordinator and primary resource for a national network of State land-grant and field libraries. It serves as the U.S. center for the international agricultural information system.

National Text Digitizing Project

More than 50 land-grant and other agriculture-related university libraries agreed to participate in a cooperative pilot project undertaken by the National Agricultural Library to collect, process, evaluate, and implement a national text digitizing image system for preserving and providing computer access to the content of agricultural library materials. If proven feasible, this process could provide access to masses of material that would otherwise be beyond useful bibliographic control because of financial limitations. NAL will prepare video disks containing both digitized text and page images and make them available to cooperating libraries for use and evaluation. The University of Vermont is acting project coordinator under a 3-year cooperative agreement with NAL.

Integrated Computer System for Library Management

An integrated library system incorporating the latest computer technology will be installed at the National Agricultural Library during the next 2 years. The system will be used to manage the library's 1.9-million-volume collection, eliminating current fragmented, multiple-computer operations and resulting in significant savings in time and money. Users will have greater access to the collection, including more timely delivery of materials and direct electronic access to bibliographic records through an on-line catalog under a contract with Virginia Tech Library Systems, Inc., of Blacksburg, VA.

Joint Catalog-Index Programs With 34 State Libraries

With the goal of providing improved access and control of State agricultural publications, 34 land-grant university libraries participated in a joint project with NAL to acquire, catalog or index, and offer document delivery of experiment station and Extension Service materials. NAL enters bibliographic records into its master AGRICOLA database and provides backup document delivery service. In another program, also intended to expand

coverage of agricultural topics, libraries with strong agriculture-related collections, including the U.S. Department of the Interior, the University of Illinois, and Ohio State University, added records of their unique agricultural holdings to AGRICOLA.

Forest Service,
FSIS Fund Databases

Expanded coverage of forestry materials in the NAL AGRICOLA database will be provided under an interagency agreement with the Forest Service. FS will fund at least three additional cataloger-indexer positions at the library to do the primary work and will also station other FS personnel there to reduce overlap and consolidate processing of materials. In another cooperative project, the Food Safety and Inspection Service began working with NAL to develop a database on food irradiation, based on materials received by the library from the ARS research center at Wyndmoor, PA.

Expert System,
Laser Disk Uses

In its continuing efforts to explore the application of new technologies to agricultural library needs, NAL implemented a number of programs to develop (1) a computer-based expert system that will help library users obtain answers to ready-reference questions, (2) an interactive video disk instruction course for searching the AGRICOLA database, (3) full text laser disk storage and retrieval, (4) database retrieval on compact disk, and (5) photo indexing on laser disk. The instructional package was developed in cooperation with the University of Maryland, and the full text and database laser projects involved selected land-grant universities as participants. In the photo indexing project, the library worked with the National Archives and the University of Maryland in putting 34,000 images from the 500,000-frame forestry collection on laser video disks.

International Ties
With UN, Britain

On-line domestic access to the foreign literature cited in AGRIS, the international agricultural literature database of the United Nations (UN), was made possible by NAL, its U.S. sponsor, through arrangement with a major commercial database system. The library prepares a special monthly tape consisting solely of citations to U.S. imprints, extracted from its AGRICOLA database, for input into AGRIS. AGRIS is a cooperative, centralized system produced by the UN's Food and Agriculture Organization, in which over 100 national and multinational centers take part. NAL also worked cooperatively with the Commonwealth Agriculture Bureau (CAB) and provided leadership in synchronizing the AGRIS- and CAB-controlled vocabularies for use among the three libraries.

Creation of New Information Units

Four additional specialized information centers concentrating on subjects of current agricultural concern--alternative farming systems, animal welfare, fiber and textiles, and family--were established to provide selective, indepth access to worldwide literature on a given topic, locate research in progress, and offer other related information services. The library now has 10 such centers in operation, the others being in the fields of food and nutrition, biotechnology, food irradiation, aquaculture, horticulture, and critical agricultural materials.

Visiting Scholar, Fellowship Programs

A scholar-in-residence program was established at NAL with the objective of attracting distinguished researchers in agriculture to make indepth use of its preeminent collections. A preeminent historian of U.S. agriculture and a specialist in aquaculture and marine science were appointed the first participants in this program. The library also signed a cooperative agreement with the University of Maryland's Department of History, establishing a fellowship program in ornamental horticulture at the university. The program, funded through a gift donation to NAL, will focus on the historical development of marketing research and information services for the ornamental horticulture industry.

Remote Sensing, Agent Orange Collections

Significant collections of materials on remote sensing and food irradiation were transferred to NAL from the Johnson Space Center, Houston, TX, and the ARS Eastern Regional Research Center, Wyndmoor, PA, respectively. A comprehensive collection of materials on Agent Orange--once used as a defoliant in Vietnam--was obtained from the Veterans Administration. Other major donations included collections on poultry from the American Poultry Historical Society and animal fibers from the Beltsville Agricultural Research Center. A special collection belonging to the late Charles Valentine Riley, pioneer scientist and entomologist, was placed on permanent exhibit at the library.

FOOD AND AGRICULTURAL SCIENCE PRIORITIES
AND DIRECTIONS FOR THE FUTURE

DEPARTMENTAL OBJECTIVES

Several of the top 16 USDA objectives for the future, as determined at the Secretary's Top Staff Conference in July 1982, are directly related to the food and agricultural sciences. They are as follows:

Help Farmers
Market Their
Products

Research and education agencies will improve the knowledge and information bases available to agricultural producers concerning presently available marketing alternatives; identify opportunities for developing new marketing alternatives; and provide information, training, and technical assistance to producers that will improve their marketing skills, practices, and strategies.

New Crops

Develop a research program that will provide the technology needed to produce new agricultural and forestry crops to meet national needs; provide for crops for arid lands, problem soils, strip-mined areas, and family farms; and develop new crops that will supply new medicinals, gums, waxes, resins, oils, proteins, hydrocarbons, and fibers for industrial use and new crops to replace crops in chronic surplus.

Increase
Efficiency

Conduct fundamental research on the physical and biological aspects of agricultural and forest products and the processes by which they can be preserved, converted into safe and useful products, and transported from producer to consumer; conduct economic research on costs and efficiency in the marketing system and the economic performance of markets for agricultural and forest products; and provide for the extension of technology and market intelligence to producers, marketers, and consumers.

NATIONAL PRIORITIES RECOMMENDED BY THE JOINT COUNCIL
ON FOOD AND AGRICULTURAL SCIENCES

In April 1986, the Joint Council identified eight major priorities for FY 1987 science and education programs. The Council recognizes the importance of strong base programs in research, extension, and teaching and urges the continued support for these programs. Those priorities selected for special emphasis are particularly appropriate because of specific problems now facing agriculture and because of opportunities for important advances in these areas.

Enhance Profitability in Agriculture

In recent years, U.S. agriculture has experienced declining net farm income and increased financial stress. This has resulted in emphasis on regaining profitability in agriculture and forestry through improved production, management, and marketing systems. Agriculture must make a transition from the current short-term farm financial crisis to a long-term, stable, and profitable situation for the agricultural community. To sustain the long-term productivity and profitability of agriculture, an integrated systems approach is needed that will maximize economic returns. Greater emphasis is needed on integrated farming systems, which are based on the appropriate new and existing production technologies, financial management, marketing strategies, risk analysis, and trade decisions.

Expand Biotechnology To Enhance Benefits From Plants and Animals

Recent scientific breakthroughs in biotechnology and genetic engineering promise to revolutionize agriculture and forestry. Biotechnology offers opportunities to design crops, animals, and microbes that are suited for specific environments and that have potentials for enhanced pest, disease, and environmental stress resistance and balanced nutrient levels. Biotechnology can provide large quantities of biologically active materials such as new vaccines and diagnostic tools for animal agriculture. It can overcome traditional constraints in research with plants; tree improvement, for example, is hindered by the long life cycle and large size of trees. As procedures are refined, emphasis should be given to providing a constant interactive process between developers and users of scientific and technological advances to assure application and use.

Improve Water Quality and Management

Protection and efficient use of water resources continue to be very important concerns in agricultural and forest production. Surface water is becoming fully allocated in many areas, and future water development will shift toward ground water supplies. Agriculture now uses 68 percent of the ground water withdrawn, and half the U.S. population depends on ground water

for drinking. Research and extension programs need to emphasize management practices that will reduce pollution of ground and surface waters; increase the quality and yield of runoff from forests and rangelands; and improve the water-use efficiency of irrigation practices.

Strengthen
Development of
Scientific and
Professional
Expertise

Agricultural expertise is vital to the security and well-being of this country. The United States, as the lead nation in agriculture, requires an adequate scientific and professional human capital base. Unfortunately, baccalaureate degree enrollments in the food and agricultural sciences have declined 30 percent since 1977. Currently, the annual demand for college graduates in food and agriculture exceeds the supply by 10 percent. There is a critical need to attract outstanding students and to enhance the ability of institutions of higher education to produce highly qualified graduates.

Enhance Productivity
and Conservation
of Soils

Accelerated soil erosion is a threat to the long-term productivity of cropland. In addition, soil compaction, salinity, loss of organic matter, atmospheric deposition, and restricted drainage also reduce productivity. Basic research and development are required to define interrelationships among tillage practices and other components of crop production systems--including soil type, crop rotation, planting and harvesting methods, varieties, fertilizer practices, and pest management--to allow improvements in cost reduction and soil conservation. Technologies must be translated and transferred to the user community.

Expand Domestic and
Foreign Markets and
Uses for Agricul-
tural and Forest
Products

The progress of American food, fiber, and forest industries depends on their ability to sustain improvements in productivity, efficiency, and product quality and to increase output in line with demand. Lagging productivity and efficiency contribute to higher prices for agricultural products, declining markets, and a loss of U.S. jobs. Labor-intensive production and processing are shifting to other countries with lower wage rates. Market development needs to focus both on new products and on new uses for existing agricultural products. Domestic and foreign consumer attitudes and preferences that affect the consumption of farm products need to be explored and satisfied to expand demand.

Preserve Plant
Germplasm and
Genetically Improve
Plants

The cost of production and the productivity of many plants can be substantially altered through genetic improvement. Elucidation of sources of desired traits and the genetic basis of inheritance will provide geneticists, biotechnologists, and plant breeders with innovative concepts and procedures to develop high-yielding, uniform plants with superior physiological and

morphological traits that are more resistant to pests, tolerant of environmental stresses, and capable of utilizing beneficial micro-organisms. New germplasm must be evaluated, assessed, and preserved to meet agricultural and forestry needs.

Improve Human Nutrition and Understanding of Diet-Health Relationships

Nutrition affects every individual from the time of conception to death. The science and education system has a major commitment to provide new nutritional facts and to disseminate research-based information that will improve the health and well-being of people. With the rapid expanse of knowledge in the science of food, nutrition, and health, nutrition education programming must become more dynamic, assertive, and efficient to meet future needs. Research is needed to improve the nutritional and health status of people by determining the health effects of food quality, bioavailability of nutrients, and dietary practices.

Other Important Topics Considered

Since public financial resources are limited, the Joint Council felt constrained to put top priority on only the most urgent problems and opportunities. In addition to the eight highest national science and education priorities identified by the Council, however, several other topics were considered worthy of increased attention and support.

These other topics, along with important base programs, will receive attention from science and education institutions and agencies to the extent that resources are available. They include improving biological efficiency of animals, improving health and controlling diseases of animals, controlling crop pests and diseases, improving food processing and enhancing the quality and safety of food, improving agricultural policy analysis and implementation, assisting distressed rural families, revitalizing rural America, and strengthening youth development.

